Integrated Ecosystem approach to rehabilitate degraded arid and semi arid lands of western India for combating desertification

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PROJECT BRIEF

1. IDENTIFIERS:

PROJECT NAME:	Integrated Ecosystem approach to rehabilitate degraded arid and semi arid lands of western India for combating desertification
DURATION	5 Years
IMPLEMENTING AGENCY	United Nations Development Program (UNDP)
EXECUTING AGENCY	State Forest Departments of Rajasthan and Gujarat
REQUESTING COUNTRY	India
ELIGIBILITY	India ratified the convention on climate change on 11/01/1993, the convention on biological diversity on 11/02/1994 and the convention to combat desertification on 17/12/1996
GEF FOCAL AREA	Multiple benefits: Land degradation, Biodiversity, Climate change
GEF OPERATIONAL PROGRAMME	OP12. Integrated Ecosystem Management (IEM)

2. SUMMARY:

The project will promote participatory integrated ecosystem management (IEM) of some globally important arid and semiarid areas of northwestern India. It covers a 28910 ha area spread over eleven sites in Rajasthan and Gujarat representing seven selected types of land degradation with the basic objective of conserving biodiversity, sequestering carbon and improving the socioeconomic condition of desert dwellers, and environment.

The seven types of degraded land are represented by: (1) degraded forest land in the Aravalli, (2) scrub land in the central Saurashtra region of Gujarat; (3) gullies and ravines in southwest Barmer district of Rajasthan; (4) degraded pastureland in Kutch and north-western Rajasthan; (5) land degradation due to dryland salting along the Little Rann of Kutch; (6) sand desert with shifting dunes in north-western Rajasthan; and (7) rocky/sandy hummocks in Shergarh tehsil of Jodhpur. The GEF alternative will build on the baseline by adopting and applying the IEM approach for combating desertification by promoting community level planning, enabling a legal and policy environment and demonstrating appropriate technical models.

In each of the project's eleven representative sites three different but integrated spatial units such as agricultural lands (farmers lands), common access resources (pasturelands and wastelands) and designated forest areas will be targeted. On farmers land, the production system will be intensified by introducing agroforestry models, adopting of soil and water conservation measures to rationalize land use and promoting food and energy self sufficiency in order to enhance the management of natural resources and reduce pressure on forest areas. Technologies will also be demonstrated to rehabilitate salt land and sand dunes to enhance both productivity and carbon sequestration. In pasturelands and wastelands, participatory integrated plans for management, adoption of silvopastoral models and sustainable use will be demonstrated. Alternative income generation activities will be promoted. In designated forest areas the joint forest management (JFM) model will be strengthened including a suitable mechanism of usufruct sharing from protection and conservation of forest resources. Capacity building and empowerment of local institutions and stakeholders for the implementation of IEM will be done.

The project will be implemented in phases over 5 years. The first phase will focus on the creation of an enabling legal, policy and institutional environment for the implementation of IEM. In the second phase appropriate models will be tested in the selected sites in combination with local knowledge and lessons learnt will be documented. In the final phase of the project monitoring of impacts, dissemination and replication of the project result will be carried out to generate global benefits as well as sustainable socio-economic and environmental benefits at the regional and national level.

3. COST AND FINANCE (US $)

Baseline Costs	GEF	Local Community	Total Costs
1 29 93 960	1 53 11 168	30 71 439	3 13 76 567

4. ENDORSEMENT OF OPERATIONAL FOCAL POINT

5. CONTACTS

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LIST OF ACRONYMS AND ABBREVIATIONS

AFRI : Arid Forest Research Institute
BADP : Banni Area Development Programme
CARs : Common Access Resources
CAZRI : Central Arid Zone Research Institute
GEC : Gujarat Ecology Commission
DDP : Desert Development Programme
DPAP : Drought Prone Area Programme
DRDA : District Rural Development Agency
GEERF : Gujarat Ecological and Educational Research Foundation
GIDE : Gujarat Institute of Desert Ecology
GLDC : Gujarat Land Development Corporation
ICFRE : Indian Council of Forestry Research and Education
IEM : Integrated Ecosystem Management
IFDP : Integrated Forestry Development Programme
IWDP : Integrated Wasteland Development Programme
JRY : Jawahar Rojagar Yojana
JBIC : Japan Bank of International Cooperation
NWDPRA : National Watershed development Programme for Rural areas
NABARD : National Bank for Agriculture and Rural Development
PAs : Protected areas
PMGSY : Prime Minister Gramin Sarak Yojana
UNDP : United Nation Development Programme
SJY : Swarn Jayanti Yojana
SEAP : State Environmental Action Plan
SOC : Soil Organic Carbon

BACKGROUND AND CONTEXT

ENVIRONMENTAL CONTEXT AND GLOBAL SIGNIFICANCE

1. The arid and semiarid regions of India cover 127.3 million ha (38.8% of India's geographical area) spread over 10 provinces of which the areas lying in Rajasthan and Gujarat cover 47 million ha (Tewari, 1994). These two provinces constitute more than 80% area of the Thar desert. This covers an area of about 0.32 million sq km, which is nearly 12% of India's total geographical area. Life in the Indian Desert is extraordinary and in spite of massive biotic and abiotic stresses, the world's largest concentration of large mammals and winter migratory birds exists in the desert. The global significance of the Indian desert lies in the fact that it is not an isolated arid zone but forms part of an extensive desert belt comprising the Sahara and the arid regions of Arabia, Iran and Pakistan. Scientific evidence and the continuity of the Saharo-Tharian region proves that the Thar is not a manmade desert but is more than 100,000 years old (Mohnot, 2000).

2. Forests in the region cover 4.36 m ha of its geographical area (8.1%) with the per capita availability of forest area being as low as 0.04 ha as against the national average of 0.08 ha, the average of 0.5 ha for developing countries and 0.64 ha for the world (NFAP, 2000). The vegetative pattern changes with rainfall gradient from grassland with isolated trees in north western parts of both the provinces to open scrubland in the middle, and open-to-dense in pockets towards the region's south east parts.

3. The region has 8 national parks and 45 wildlife sanctuaries covering an area of 2.65 million ha (FSI, 1999). Some of these for instance, the Wild Ass sanctuary situated in the Little Rann of Kutch are internationally important. The region also has important wetlands like the Sambhar lake (a Ramsar site), Pichola Lake and Nalsarovar, which are of national importance. Some of the best-known grasslands of the country, Banni and Velavador are located in Saurashtra and Kutch regions of Gujarat. In the Thar desert, the grasslands are prominent in Jaisalmer, Barmer and Bikaner districts, especially near the Indo-Pakistan border where the human population is low.

4. The carbon pool worked out for the forests and pasture areas of Rajasthan and Gujarat is 87.63 and 72.13 Tg (10^{12}g), respectively, covering the aboveground biomass and top 15 cm of soil carbon (Ravindranath, 1997; FSI, 1999).

5. Seven eco-zones on the basis of land degradation type have been identified in these two states, which are facing severe degradation due to anthropogenic and climatic factors (Annex E provides biological diversity of the selected sites).

DEGRADED PASTURELANDS

6. This is the dominant system of land use in northwest Rajasthan and the Kutch region of Gujarat. A total of 2.59 million ha is categorized as permanent pastureland in the both the states (FSI, 1999), and is in a highly degraded state because of pressure from human and livestock populations. The average precipitation is 326 mm and drought is a recurring feature in the area. In the Banni grasslands of Gujarat (once the largest grasslands in Asia) *Prosopis juliflora* is predominant and aggressive encroaches upon rangeland/pastures in the area. In western Rajasthan, the pastureland has rarely any tree species except *Prosopis cineraria*, occasionally. These grasslands have important faunal diversity also. The black buck (*Antilope cervicapra*), chinkara (*Gazella gazella*) and a large number of birds such as the Great Indian

Bustard (*Choriotis nigriceps*), floricans, quail, partridges, warblers and babblers, are found here. The Great Indian Bustard is in the endangered category of the IUCN Red data list.

SCRUBLANDS

7. These are found mainly in the central highland area of the Rajasthan and Saurashtra plateau in Gujarat. The area of degraded scrublands in both the states is estimated to be about 4.9 million ha (GoI, 2000). Depending upon the climatic and physiographic situation a highly degraded mixed dry deciduous and thorny forest predominated by shrub species along with scattered and isolated trees is common in the region. In Gujarat, the tract lies close to the Tropic of Cancer and enjoys a tropical climate. The vegetation in this area is composed largely of *Acacia nilotica, Acacia jacquemontii, Acacia leucophloea, Acacia senegal, Acacia tortilis, Anogeissus latifolia, Azadirachta indica, Bauhinia racemosa, Butea parviflora*. In Rajasthan the scrubland is distributed mainly in the central highlands and the southwestern parts. The most common species is *Prosopis cineraria* while others are *A. tortilis, Tecomella undulata, Zizipus nummularia* and *Salvadora oleoides. Z. nummularia* in the plains and *Calligonum polygonoides, Leptadenia pyrotechnica* and *Calotropis procera, Crotolaria burhia* in the uplands dominate the undulating sandy terrain.

DEGRADED FORESTLANDS

8. The forests harbour most of the floral and faunal diversity in the region. The degraded forestland in both the states is about 1.80 m ha (GoI, 2000). The forests in the region are mainly found in the Aravalli range and adjoining sandy plains. The Aravalli range stretches from northeast Gujarat to Delhi and divides Rajasthan into three distinct climatic regions. The Udaipur zone of the range is estimated to be around 300 million years old. It is, therefore, not surprising that the range is a unique amphitheatre of biological diversity. The Aravalli range is also the source of many rivers and rivulets in the area, and Sabarmati is one of them that make a boundary area covering dry mixed deciduous forests of the tropical dry deciduous group. Some common species found in the forest region are *Anogeissus latifolia, Boswellia serrata, Lannea grandis, Acacia catechu* etc. The degraded areas have 60-100 plants ha^{-1} with an *Acacia leucophloea* population of about 30%. Among the grasses, *Themada triandra, Dicanthium annulatum, Heteropogon contortus* are useful fodder species which, however are threatened by invasion of *Aristida* spp.

SALT-AFFECTED LANDS

9. Salt-affected lands covering the fringes of the Rann and river basins of the Banas, Ropen and Saraswati in Gujarat have the potential to sequester significant amounts of carbon, conserve biodiversity and improve the socioeconomic status of the people living there. Salt-affected areas in Gujarat cover about 3.02 m ha (GEC, 2001) covering the Greater Rann and the little Rann of Kutch in the northwestern region of the state. The Rann fringe area supports saline herbaceous vegetation i.e. *Suaeda spp., Salvadora spp., Capparis spp.,* and *Calotropis procera*, and a variety of grasses. This region is known internationally for its faunal diversity and the famous Wild Ass Sanctuary. Another site, which represents a different type of salinity development process, is situated in the river basin of Sarswati, Ropen and Banas in Patan district of Gujarat. The area is climatically similar to the adjacent Rann fringes area.

GULLIES AND SANDY RAVINE FORMATION

10. The western slopes of the Aravalli hills in and around the Siwana and Kundal ranges in Barmer district, Puran in Jalore district and some places in Sikar, are prone to the formation of gullies and sandy ravines formation, which are both the main form of degradation in the region. Gullies and ravines cover about 0.6 million ha of area in both the states (GoI, 2000). The Aeolian deposition of thick layers of sands in the hill slopes is susceptible to water erosion because of run-off flow from the barren hillocks.

SHIFTING SAND DUNES

11. The shifting dunes in the north west of Rajasthan are the dominant land formation. The region is characterized by an arid landscape and has large sand dunes 50 to 100 m high and 8 to 10 km long. It is the most inhospitable region of the state and together with the scarcity of water the living conditions are very harsh. The region is covered with wind-blown sand giving rise to pockets of shifting sand dunes and semi-stabilized dunes of older origin, interspersed in alluvial soil. Extreme aridity, marked with high summer and low winter temperatures, is its usual climatic characteristics. The soils associated with dunes and interdunal plains are deep, excessively drained, calcareous or non-calcareous, sandy by nature. Among the tree species *Prosopis cineraria, Tecomell undulata, Salvadora persica* are common with their density varying with rainfall distribution. Most of the area is devoid of vegetation, but occasionally *Aerva pseudotomentosa, Leptadenia pyrotechnica, Calligonum polygonoides, Acacia jacmonttii, Calortopis procera, Prosopis juliflora* are found. *Lasiurus sindicus, Cenchrus ciliaris and Cenchrus setigerus* are some important fodder grasses found in the flat areas of the region.

ROCKY/HUMMOCKS AREA

12. The rocky/hummocks area is located in Shergarh tehsil of Jodhpur. It has a typically arid climate and is covered by wind-blown sand interspersed with rocky outcrops of varying height. The barren rocky type of wasteland covers about 0.81 million ha (GoI, 2000). Adverse climatic conditions and a sandy landscape result in the frequent failure of agriculture. Due to sandy soil/rocky outcrops and the dry climate, only shrubs and thorny bushes are found in the area. The vegetation is dominated by *Prosopis juliflora* and *Capparis deciduas* with other species like *Acacia jacquemontti, Balanites aegyptiaca,* etc. on the hill slopes. In the village commons and agricultural fields *Prosopis cineraria, Aerva pseudotomentosa, Tephrosia purpurea* and *Calotropis procera*. Among the grasses common species are *D. agiptiacum, Elsine compressa, Cenchrus biflorus,* and *Aristida funiculata,* etc.

SOCIO-ECONOMIC CONTEXT AND ANTHROPOGENIC PRESSURE

13. Vast stretches of land in the two states face degradation in various forms due to a number of factors including climatic variations and human activity. These areas are among the most populous desert areas in the world, with a population density of 199 persons per sq km. This density over a period of two decades has increased by about 86% (Census of India, 2001). The present economy of Rajasthan and Gujarat is dominated by agriculture; livestock-rearing is a subsidiary occupation. Agriculture as the main sustenance resource is practiced by more than 60 per cent of households. Livestock farming occupies an important place in the economy of the region.

14. Agro-pastoralism is most commonly practiced more than two-thirds of the total number households of different communities earn their livelihood from a combination of agriculture and livestock. Agriculture and pastoralism are risk-prone and need to be supplemented with other types of alternative farming. The number agro-pastoral groups in the region is increasing faster than that of pastoral groups, and in many places this encourage desertification by continuously pushing cultivation towards the more arid areas that are less suitable for sustainable agriculture. According to one estimate, the livestock density (animal units per hectare of grazing land) in Rajasthan increased by 39% during a period of 25 years (Rollefson & Rathore, 1998). On an average, 63% of total households are dependent on agriculture and animal husbandry in the project area. Agriculture remains largely rain-fed with only 18% area having facilities for irrigation.

15. The pressure on common access resources (CARs) has increased rapidly as a combined result of the reduced area of these resources and population growth. For instance, the average number of persons per 10 hectares of common property resources ranged from 13 to 101 in 1951; by 1982, the same measure had increased to 47 238 (Jodha, 1992). Despite a rapid decline in their area and productivity, common property resources constitute an important part of community assets and pockets of biodiversity conservation in the dry areas of India. They are sources of a range of physical products, offer employment and income-generation opportunities and provide broader social and ecological benefits.

16. The dependence for sustenance on land-based resources forests, agriculture lands and pasturelands are significant. The degradation of these resources has consequently affected the well being of the population. The low carrying-capacity of semi-arid and arid systems combined with increasing population, both human and livestock has increased the stress on fragile ecosystems leading to a widespread degradation of resources. The situation is further aggravated by low and variable precipitation, heterogeneous (including sub-marginal/fragile land) resources, low regeneration capacities, limited and high-risk production options, etc. Inappropriate land use caused due to faulty agricultural practices and water management, overgrazing and a large livestock population, unsustainable fuel wood collection, mining and other industrial activities have further accentuated the degradation of land in the region. Salinity ingression and salinity build up are the causes of land degradation in the coastal and inland areas, of Kutch respectively.

17. The changing structures of the government and breakdown of social controls and indigenous knowledge have also affected the management of these resources by disrupting traditional management systems. All this has resulted in various forms of resource degradation: emergence of salinity, coverage of fertile soils by shifting sands, reduced perennials, and an increase in the number of inferior annuals and thorny bushes leading to a reduced per capita availability of productive resources.

18. The degradation of land resources has led to a decline in the productivity of the systems consequently the biomass density of forest areas, grasslands and scrublands has declined. Lowering the carbon sequestration potential of land resources.

LEGAL AND POLICY CONTEXT

19. India has been a signatory to all the major conventions on global environment-related issues. India has signed and ratified all the international environmental conventions viz. the Convention on Climate Change and the Convention to Combat Desertification. India became a party to the Convention on International Trade in Endangered Species (CITES), the World

Heritage Convention in 1977, and the Convention on Biological Diversity in 1994, to achieve the goals of conservation and sustainable use of biological diversity through consolidating ongoing efforts which include regeneration and rehabilitation of threatened species, secure participation of all stakeholders, realize consumptive and non consumptive value of biodiversity, ensure benefits to the country and to local communities.

20. The national land use policy (1986) takes into account the environmental, social, demographic, economic and legal issues. The policy is intended to have dynamic conservation, sustainable development and equitable access to the benefits of intervention as its thrust (GoI 2000a). The National Land Reforms Policy allows greater access to land by the landless rural poor and provides guidelines for the introduction of land reform legislation or amendments to be initiated by the states and union territories (GoI, 1998).

21. The National Forest Policy of 1988 aims to ensure environmental stability and the maintenance of an ecological balance including atmospheric equilibrium which is vital for the sustenance of all life forms, human, animal and plant. It further states that one of the essentials of forest management is increasing forest cover to about 33% of total land cover with special emphasis on semi arid and desert tracts. Under Draft Grazing and Livestock Management Policy (1994), the Ministry of Environment and Forests constituted a policy advisory group on grazing and livestock management in 1993. The National Policy for Common Property Resource lands (CPRLs) seeks to provide support to the people and their production systems through restoration, protection, regeneration, upkeep and development of CPRLs. The policy, inter alia, states stopping of privatization of CPRLs, control of encroachment, involvement of village communities/user groups in planning regeneration and management. The claim of poorer sections to the produce of CPRLs has been mentioned specially. Voluntary agencies and NGOs may be involved as facilitators rather than implementers.

INSTITUTIONAL CONTEXT

22. Action to combat desertification has been a priority for the Government of India for many years. India has an institutional structure in the Ministries of Agriculture/Rural Development and Environment and Forests together with national and state level land-use boards. The National Level Working Committee (NLWC) is located in the Department of Land Resources, Ministry of Rural Development; it oversees and coordinates the work of the National Land-Use and Conservation Board (NLCB), National Wastelands Development Board (NWDB), and the National Afforestation and Eco-Development Board (NAEB). The Ministry of Environment and Forests (MoEF), is responsible for planning, promoting and co-ordinating environmental and forestry programmes at the national level. At the state level, state land use boards (SLUBs) under the chairmanship of the chief minister are responsible for co-ordination and implementation of related central/state schemes and programmes. In Gujarat and Rajasthan different agencies/organizations are working towards the implementation of programmes/schemes related to combating desertification.

THREATS AND ROOT CAUSES

23. The problems facing integrated ecosystem management through conservation of globally significant biodiversity and increasing carbon sequestration in arid and semi-arid regions of northwestern India arise mainly from five related issues: (1) deforestation and removal of natural vegetation for cropping or cattle-rearing, road construction, urban development etc, (2) overgrazing, (3) improper land management including cultivation of fragile soils, reduced

fallow, (4) diversion of rivers for irrigation or irrigation of inadequate soils. (5) overexploitation of vegetation for fuel, fodder, fencing, etc. An increase in mine spoils, diversion of population to urban areas and industrial activities are other sets of problems originating in the region which have intensified pollution.

24. The project development process conducted a major participatory planning exercise with representatives of stakeholders, i.e. farmers, transhumant pastoralists, village community, women, non-government organisations (NGOs), self-help groups (SHGs), agriculture, livestock and forestry extension services and all baseline projects as well as villages leaders as rural advisors. This process identified seven prioritized degraded lands where the restoration and conservation of globally significant biodiversity and increasing carbon sequestration were a priority. The threats observed in these seven priority areas covering eleven sites are: land conversion for purposes other than forestry or grazing, overgrazing of CARs and pasturelands, deforestation, over-exploitation and selective extraction of natural resources and non-timber products. Annex I contain an analysis of threats and root causes analyses and a matrix for threats, root causes and alternative strategies.

INTENSIFICATION OF THE AGRICULTURAL PRODUCTION SYSTEM

25. Conversion of forest, pastureland into crop lands or encroachment upon the CARs for agricultural production is pushing pastoral activities more and more into forest areas even in reserved forest and PAs. The main problem is the gradual extension of cultivation to hill slope or fragile sandy terrain, which was previously left aside because of the fragility of soils or of other limiting factors. This is a common phenomenon in situations of land hunger, i.e. of high population density *vis-à-vis* arable land. Population growth requires the extension of interference into new areas of lower resilience and higher sensitivity for which existing management practices may be inadequate which leads to land degradation unless particular measures are taken to protect soil structure and maintain fertility. Movement and resettlement of forest tribal and consequent clearing of forest area for agriculture is the example of such type of degradation. Improper practices such as faulty intensification, shortening fallow, insufficient fertilization, excessive fertilization, or the various forms of inadequate management of irrigated areas. The elementary way to extract more produce from land which is not cultivated permanently, is to shorten the fallow period to which it is subjected. However, the absence of other technological changes, led the growing poor rural population to increasingly degrade and mine the natural resources in an effort to ensure their day-to-day survival. Further, under permanent cropping, the need for increased produce leads to irrigation and fertilization, as well as to higher cropping intensities, which resulted in land degradation problems such as salinization and water logging of irrigated areas, and pollution by pesticides or fertilizers.

26. One factor with a significant bearing on soil properties related to productivity is soil organic matter (SOM). Clearing of forestland, intensive cropping and imbalanced fertilizer application all lead to depletion of SOM. The organic carbon content has declined significantly because of enhanced oxidation of the soil organic matter, which is due to intensive farming. Since the SOM status was found to increase from as low as 0.25% to 0.85% in long-term soil fertility management, it is obvious that the present levels are much below the climate-driven equilibrium in arid and semi-arid areas (Swarup, 1998). The benefit of improving the organic carbon status of the soil was observed at several locations and needs to be given priority as it is of paramount importance in controlling land degradation in rainfed areas. It should be maintained at least at the current level through greater biomass input, optimum tillage and other soil management practices.

OVERGRAZING

27. Excessive pressure on forests, pasturelands and common access resources (CARs) by livestock is a critical problem in dry areas where rangelands and CARs are much more crowded. While livestock does not necessarily cause environmental problems, overgrazing is a major factor in deforestation and land degradation. The growth of livestock population leads to the extension of grazing activity into forests and semi-arid marginal lands ultimately causing their degradation. Even where grazing is allowed (e.g. CARs and pasturelands), the lack of effective regulations for natural management leads to overgrazing, conflicts between residents and non-residents, transhumant and conflicts between farmers/foresters and pastoralists. The high pressure of livestock on grazing lands, particularly in view of their low carrying capacity, has resulted in the overuse of these lands and depletion of the natural vegetation resources. Selective, overgrazing favours the encroachment of undesirable species such as *P. juliflora* in CARs and pastureland leading to a different set of problems. For example, studies have shown that the cover of *Sehima nervosum* reduced to about 0.2% from 11.5% due to the impact of grazing. Similarly, the high basal cover of *Cenchrus ciliaris* and *C. setigerous* on the sandy loam soil of Sojat reduced to just 0.5% from 19.8%. On the sandy loam soil at Hajri (Jalore district) the initial basal cover (24.0%) of *Dichanthium annulatum* was reduced to only 5% due to unrestricted grazing. Furthermore, the absence of readily available intensification and diversified income-generation techniques, particularly for small ruminants that are appropriate to the socio-economic and ecological conditions exacerbate the pressure on forests, pasturelands and CARs.

DEFORESTATION

28. The removal of vegetative cover starts or accelerates soil losses by wind or rainwater. The other cause of destruction is overuse by households, mainly for fuel wood collection. To cover vital energy needs, most households in the area resort to free gathered biomass fuels, including crop residues and animal dung but most of all, fuel wood. The annual use of wood always exceeds the sustainable yield of forests or wooded areas, forests and woodlands are gradually destroyed. This in turn triggers or accelerates soil erosion and a loss of productivity in the region. The impact of population growth on fuel wood consumption in the vast areas concerned is direct, since energy needs are essentially proportional to population. Added to this, is population dynamics, which plays an important role in urbanization. A first effect arises from population concentration, which makes the impact on resources acute over a peripheral zone, typically suffering disproportionately from deforestation. A second effect arises from changes in habits: urban dwellers frequently prefer charcoal to wood; this increases the impact on wood resources per consumption unit.

DRY LAND SALTING

29. At present 1.04 million ha suffer from salinity and alkalinity with an additional 1.86 million ha of marshy tract covering the Rann of Gujarat. Irrigation with saline soil water and over-irrigation in drained soils having a salt-rich hard pan at medium to shallow depth have both accelerated the salinity-alkalinity build-up in many parts of the medium-to-heavy textured alluvial plains. Excess irrigation in locations having a gypsum-rich soil layer at shallow depths and inadequate drainage is the major cause for land degradation in this area. Salinity ingression from the sea also causes degradation and salinity-alkalinity buildup limits the productivity of vast areas of agricultural land. Further, wind-blown tiny salt particle from the little Rann of Kutch are deposited on adjacent agricultural fields and gradually increases the salinity in that area also. These processes adversely affect the productivity of the Rann

fringe area. Lack of sheltering and vegetation in saline-alkaline Rann fringe areas forces the people into nomadic activity. The damming of the Saraswati, Ropen and Banas rivers has also caused salinity as the fresh water, which used to reduce the salinity of the area through flushing with fresh water, is no longer available in the river basin area of Patan district of Gujarat. In the coastal plains excessive pumping of potable water along the seaward margin is now leading to the intrusion of seawater into fresh water aquifers. Since they do not have any other choice, the farmers continue to use sea-replenished ground water for irrigation despite its poor quality. Lack of incentive, proper resource management techniques and the high cost of saline land vegetation are the major problems in the area.

OVER-EXPLOITATION AND REMOVAL OF VEGETATION

30. Sustainable harvesting is traditionally based on a diverse range of products. The scale of harvesting is mostly limited to self-sufficiency in various day-to-day uses and/or commercial exploitation. Over-exploitation of *Calligonum polygonoides* from the dune area for fuel, of *Dendrocalamus strictus* and *Chlorophylum borivilianum* (safed musli) for multiple uses (including it's medicinal value), from the forest areas are present examples. Because of the decrease in economic returns from crop cultivation, there has been an increase in the harvesting of these products from protected areas. Evidence suggests that the rate is high enough to affect the regeneration of the plants, as well as feed sources of wild animals. Lack of incentives from co-management, result in opportunistic action by local communities.

31. Destruction of natural plant cover and the large-scale introduction of tractor ploughing in the sandy terrain, including the dune slopes, is increasing the sand load manifold for aeolian processes and is threatening more areas through new dune formation and the advancement of old dunes. This is a common phenomenon in arid and the desert regions mainly in sandy-dune and other sandy areas. In the Aravalli hill ranges, wind blown sand is regularly deposited on the hill slopes and they are denuded of natural vegetative cover. Consequently, soil washout results in sheet, rill and gully erosion. Sometimes, there is hardly any soil left to start an afforestation programme.

BASELINE COURSE OF ACTION

32. Having recognized desertification as a major problem in the region, efforts have been initiated to control it by various government and non-government agencies. Schemes funded by the union government, state government and external multilateral funding agencies focus on wasteland development, addressing the proneness to drought of the area, soil conservation measures, poverty alleviation etc. However, the absence of an integrated and multidisciplinary approach, scattered knowledge, lack of people's participation and on the spot treatment to control desertification have resulted in only limited success for the programmes. A number of institutes are engaged in devising systems to address the issue, but there is a want of effective linkages between the development of systems and their dissemination in the field. There are no effective institutional mechanism either, linking the research institutions with implementing agencies. The forest department, which is primarily responsible for arresting degradation of land and combating desertification, is dependent on government support. The orientation towards leveraging private resources to address these issues is highlighted in policy documents but has yet to be translated into practice. The lack of adequate implementing staff is another major constraint in the way of implementation. There are few policy and other market-based incentives to promote a more sustainable model of natural use among farmers and pastorals.

33. The following is a brief outline of various centrally-sponsored programmes, being implemented by different ministries with the focus on combating desertification, and mitigating the effects of drought.

34. **Afforestation Programmes:** Ministry of Environment and Forests in consultation with the state government fixes targets annually for afforestation/tree planting activities. These are taken up under schemes/programmes of different central ministries/departments and of state governments. During the last 50 years, since independence, around 27 m ha of land has been brought under tree cover in various plan periods at a cost of about Rs 70 000 million (GoI, 1999a). These include major schemes/projects related to forestry that help combat desertification and drought. External assistance in the forestry sector started in 1980 with the implementation of the World Bank-aided Social Forestry projects. The Desert Development Programme (DDP) was initiated in 1977-78 and up to 1994-95, a total of 5 52 669 ha was covered under different components of the programme (Government of India, 1998b and 2000a). Like the Drought-Prone Area Programme (DPAP), this programme is being implemented on a watershed basis only. However, in hot sandy arid areas where it is not possible to delineate a watershed these programmes are taken up on the basis of village clusters. Sectoral activities are sand dune stabilization, shelterbelt creation and afforestation. These programmes ensure people's participation in the planning and implementation by creating 'watershed associations' comprising the adult population of the watershed. They elect Watershed Committees, which are responsible for planning and implementing the watershed development projects.

35. **Rural development:** The Rural Works Programme (RWP) was initiated in 1970-71 and was the first major effort in this direction. Its objectives were to create durable assets in the rural sector, which could contribute towards reducing the severity of drought wherever it occurred and provide wage employment to the affected population. The RWP was redesignated the Drought Prone Areas Programme (DPAP) in 1973-74 and focused on problems of drought prone areas only. At present the DPAP is being implemented in 947 blocks of 161 districts in 13 states. The total area covered under different components of the programme since its inception to 1994-95 is about 5.7 million ha. From 1995-96 to 1998-99, work in 6057 watershed projects, each of about 500 ha, has been carried out at an expense of Rs 522.37 million (GoI, 1998b and 200a). Sector activities are: (1) land resources development, (2) water resources development, and, (3) afforestation and pasture development.

36. **Land resource development:** The National Watershed Development Project for Rainfed Areas (NWDPRA) was initiated in 1990-91 during the Eighth Five Year Plan (1992-93 to 1996-97). It envisaged the treatment of arable lands only and consisted mostly of crop production components. The programme was redesigned in 1992-93 with a focus on the development of micro-watersheds as models of comprehensive and integrated development in different agro climatic regions of the country. The new programme includes measures such as conservation on arable lands and development of multi-tiered vegetation consisting of grasses, shrubs and trees. At the end of the Eighth Plan an area of 4.3 million ha was developed covering 2,554 watersheds in 25 states and two union territories at an expenditure of Rs 9 715.2 million (GoI, 2000b). The Integrated Wastelands Development Programme (IWDP) is under implementation on a watershed basis under the common guidelines for watershed development. During the Eighth Plan (1992-93 to 1996-97) a total of 284 000 ha have been treated at cost of Rs 2167.6 million (GoI, 1998b). The Council of Advancement of People's Action and Rural Technology (CAPART) has the mandate to promote voluntary

action and to propagate appropriate rural technologies among the rural people. By February 2000, the Council had supported 211 community-based project-implementing agencies (PIAs) for watershed management programmes in the country.

37. **Sand dune stabilization and pastureland development:** The Indira Gandhi Nahar Project (IGNP) covers the western part of the Thar desert. It provides irrigation to over 2.5 million ha of the Thar Desert of which 1.2 million ha is the cultivable command area. Under an externally-aided (Japan Bank of International Cooperation (JBIC) project, a total area of 33,725 ha which includes sand dune stabilization (16,114 ha), canal-side plantation (11,522 ha), road-side plantation (603 ha), block plantation (2,279 ha) and pasture development (3,207 ha) has been covered since 1990-91 to protect IGNP against deposition of sand and to develop adjoining arid lands.

38. **Protected area network:** In the past 25 years, the network of protected areas (PAs) has expanded from 10 national parks and 125 wildlife sanctuaries to 85 national parks and 447 wildlife sanctuaries in the country. Within these PAs, 23 tiger reserves covering a total area of 3.30 million ha have been established. These 532 PAs together cover nearly 15 million ha, which is about 5 per cent of the country's geographical area and about 23 per cent of forest area (Government of India 1999b and 2000). Of these PAs, 8 national parks and 43 wildlife sanctuaries are located in arid and semi-arid areas of Rajasthan and Gujarat. These are not only repositories of natural biological diversity but have also helped in combating desertification.

39. **Poverty alleviation and social programmes:** Other measures/schemes such as Jawahar Rojgar Yojna (JRY), Swarn Jayanti Yojana (SJY), Indira Awash Yojana (IAY), Pradhan Mantri Gramin Sarak Yojana (PMGSY) are also being implemented to alleviate poverty and generate rural employment with focus on horticulture and watershed development. In addition to these, is the Member of Parliament's (MP's) quota of Rs 20 million per annum for the social upliftment of the rural people in the area. At state level, different organizations and schemes such as Gujarat Land Development Corporation (GLDC), Tribal sub-Plan, Member of Legislative Assembly (MLA's) quotas are also involved in the area to improve the live status of the desert dwellers.

PROJECT RATIONALE AND OBJECTIVE

40. The overall long term objective of the GEF alternative is to promote Integrated Ecosystem Management in seven different eco-zones in Rajasthan and Gujarat to generate global benefits from enhanced biodiversity conservation and carbon sequestration, as well as national benefits from sustainable use and equitable sharing of benefit. It will also aim to reverse the process of land degradation in arid and semi-arid ecosystems and promote the sustainable use of land resources for arresting desertification and improving the socio-economic (poverty, food security, health, risk) situation. The GEF alternative will build on the baseline by consolidating lessons learnt and alternative models will be tested in representative sites in northwestern India and will be complemented by upstream activities in policy reform, capacity-building and monitoring.

41. The project will promote participatory integrated ecosystem management (IEM) of globally important arid and semi-arid areas of northwestern India. It covers 28 910 ha areas spread over eleven sites in two states of Rajasthan and Gujarat representing seven selected type of land degradation in the region with the basic objectives of conserving biodiversity, sequestering carbon, improving the socio-economic condition of desert dwellers and

environment.

42. The pressure of a rapidly increasing population on the natural resources in the region has led to the realization that pure conservation will no longer be effective in combating desertification in the area. The model adopted by the project will integrate a series of co-managed conservation, community-based management of CARs, pasturelands and forest lands, local land use planning and sustainable harvesting activities in an integrated manner based on IEM principles. IEM will be promoted through capacity-building and enable activities both at the local and regional levels through the polyvalent extension services, which provide the structure for integrated work. Each of the project's 11 representative sites contains three different but integrated spatial units. These units and the activities that will be targeted selectively to them are:

> **(a) Farmers' field:** To support alternative technologies for low external-input and intensification of agriculture (crops and trees/livestock) with a suitable model of agroforestry. It will supplement the requirement of fuel wood and secure the productivity of degraded lands of this highly fragile environment. Integrated eco-regional planning will be promoted to rationalize land use and IEM. Agricultural intensification is expected to reduce emissions of carbon from the land and the introduction of multipurpose trees into agricultural fields will increase the carbon stock as well as the supply of fuel and fodder.
>
> **(b) Common access resources (CARs):** The project will encourage and build capacity for the sustainable management of community land resources following the eco-regional principle of reducing pressure from the forests for grazing and fuel wood collection. Communal management and control of the community lands, appropriate sustainable harvesting related to fuel and fodder, links to forest areas management, rehabilitation of degraded areas, and access to the local credit and saving, are all issues requiring attention in community land management. Rehabilitation and reforestation will result in a significant amount of carbon sequestration and biodiversity conservation.
>
> **(c) Forest areas:** The project will build on the baseline, by filling in gaps related to conservation, capacity-building of the village community and forestry staff in eco-regional planning and participatory protection, management and regeneration of forests. In addition, the project will build institutions and capacity for co-management with local communities i.e. JFM to increase productivity, conserve biological diversity and enhance carbon sequestration.

43. These field-level activities will be complemented and supported by local and provincial-level activities at capacity-building, inter sectoral policy and legal reform for IEM (Annex C).

44. The GEF increment will build upon the baseline and co-financing, to cover the related additional costs to achieve global benefits (Annex B). In general, co-financing will cover the cost of sustainable development activities, promoting livelihood strategies, investment in production inputs, and replication of successful models. The GEF increment will cover the costs of developing, testing and demonstrating the integrated conservation/development and eco-regional planning models in the selected 11 sites. The GEF increment will also lift barriers to the sustainability and replicability of the integrated conservation and development and sustainable eco-regional models. These barriers are technical, economic, political and institutional in nature. The GEF increment will address these barriers at the local and regional

level in the form of appropriate technologies, institution-building, economic incentives, capacity-building and inter sectoral policy reform and legal clarification.

PROJECT SITES

45. The project will be implemented in eleven selected sites, five in Gujarat and six in Rajasthan in the seven identified eco-zones covering three integrated spatial units viz., the farmer's field, common access resources and forest areas. About 73 such community lands have been identified to demonstrate the integrated ecosystem management (IEM) approach.

PROJECT ACTIVITIES/COMPONENTS AND EXPECTED RESULTS

46. The planning process of the project developed its logical framework, including an indicative list of activities, verification indicators, meanS of verification, and assumptions. A brief description of the expected output and GEF increment for each component are provided below.

Immediate Objective 1: To identify policy and legal obstacles in adoption of IEM for combating desertification and advocate appropriate measures

The current policy and legal provisions are not very conducive to the rehabilitation of common access resources and promotion of tree cover on private land. The project will identify the policy and legal barriers and recommend remedial measures. Advocacy and opinion-building of the remedial measure will be undertaken to influence the policy makers. The expected output and the planned activities are given below:

Output 1.1 Policy and legal obstacles in adoption of IEM for combating desertification identified and appropriate measures advocated

1.1.1 Identify legal and policy constraints for rehabilitation of CARs and suggest remedial measures

1.1.2 Identify legal and policy constraints in integrated management of private lands resources and suggest remedial measures

1.1.3 Advocate/build opinion of recommended policy and legal measures for rehabilitation CARs.

1.1.4 Advocacy/opinion-building of recommended policy and legal measures to encourage integrated management on private and community lands.

The project will build upon strengthened capabilities of existing institutions having adequate linkages with the ongoing programmes. Adequate precaution will be taken to ensure that the institutional mechanism will not operate against the mechanism of other ongoing programmes, but will complement the current mechanism.

Output 1.2: Local traditional management systems of CARs documented and community based institutional arrangement for its sustainable management strengthened

Local traditional management systems of CARs will be documented to understand the process and identify major factors for its continual operation. These will form the inputs to designing institutional arrangement with adequate representation of women and the people of weaker sections for the management of CARs by adopting a participatory approach. The activities undertaken to achieve this will be:

1.2.1 To document traditional management systems adopted by existing village institutions for management of CARs

1.2.2 To identify and promote measures to strengthen community-based institutional arrangements for sustainable management and development of CARs

Output 1.3: Institutional mechanism of promoting integration of sectoral issues among various line departments for planning and implementation of IEM identified and advocated

Efforts will be made to link up with various government departments and other institutions to provide better services to the village community. The following activities will be undertaken to achieve this output.

1.3.1 Identify legal and policy constraint among various line departments and suggest measures to integrate them

1.3.2 Advocacy for integration of sectoral issues among various line departments

Immediate objective 2: To demonstrate models for integrated ecosystem management of land resources to increase productivity and carbon stock as well as the livelihood status of desert dwellers

This objective involves the demonstration of different models for the sustainable management of land resources such as agricultural land, saline and sand affected land, CARs, degraded pasture and forest lands. The activities under different models will help to rehabilitate the degraded land resources, which will otherwise help in combating desertification. It will increase the supply of fodder and fuel to the local community in addition to the increased carbon stock. Improvement of livelihood status of the rural community is an integral component of all the interventions.

Output 2.1 Sustainable land development models including soil and moisture conservation measures on agricultural land through intensive and diversified production system demonstrated

In this activity agroforestry models will be promoted as an alternative land management system for agricultural lands. Agroforestry models in addition to diversifying the agricultural production system, will increase the farms income and enhance soil and water conservation. The land conservation model will have two components. First, will be bunding and live hedges to reduce the air and water erosion of soil. Secondly, some well-adapted/ tested systems/technologies including agri-silviculture, agri-horticulture will be demonstrated. These will be implemented via the participation of the beneficiaries. The activities that will be undertaken to achieve the outputs are:

2.1.1 Demonstrate, promote and replicate field bunding and live hedges and other site-specific activities for soil and water conservation

2.1.2 Demonstrate and promote agri-silvicultural models on agriculture lands

2.1.3 Identify incentive structures for promotion of agri-silvicultural practices

2.1.4 Demonstrate and promote agri-horticultural models on agriculture lands

2.1.5 Demonstrate nursery development for multipurpose tree species and horticultural species

2.1.6 Provide technical assistance in adopting local improved breed cattle, goats, poultry farming and bee-keeping

2.1.7 Organize livestock health monitoring and training camps

Output 2.2 Sustainable land development models to reclaim salt and sand-affected land demonstrated

Various technologies to improve the productivity of salt land and stabilization of sand dunes will be demonstrated. Introduction of soil and moisture conservation practices along with surface vegetation cover will increase the productivity of these desert sites with very sparse vegetation cover. It will enhance fodder and fuel wood availability for the local people and income through minor produce such as the sale of *C. augustifolia* leaves. Tested afforestation technologies with special emphasis on soil and rainwater conservation will be implemented through participation of the beneficiaries. The activities to achieve the outputs are:

2.2.1 Demonstrate techniques to stablize sand dunes, ravines and rocky hummocks for habitat improvement and income diversification

2.2.2 Demonstrate techniques to reclaim saline soils for productivity enhancement

Output 2.3 Conservation and sustainable management of CARs and pastureland demonstrated

Different management practices for improvement and development of CARS and pastureland will be demonstrated to increase their productivity and to decrease the pressure on the forest resources. A participatory microplan is the key to this intervention. Soil and water conservation practices are important aspects in the improvement of productivity. Regulations to control livestock grazing will also be advocated. Various site-specific silvopastoral models will be executed in consultation with local institutions. The following activities have been outlined to achieve the output:

2.3.1 Develop a participatory plan for the management of CARs for increased biomass production and promote alternative energy sources

2.3.1.1 Develop microplans for management of CARs based on the needs of the village community (including nomadic groups) and its carrying capacity

2.3.1.2 Develop village energy plans incorporating the demand-side management of wood and alternative energy sources

2.3.1.3 Identify and promote measures to strengthen accesses and enforcement rules of good management of CARs including fines for infractions at village/panchayat level

2.3.1.4 Establish and manage mechanisms for self-financing of CAR management such as user fees and sale of products

2.3.2 Site-specific silvi-pastoral models for sustainable use-regimes on CARs

2.3.2.1 Soil and water conservation based on the topography of the site to improve the productivity of the land resource

2.3.2.2 Establishment and management of 210 ha grass seed production areas

2.3.2.3 Revegetation of CARs with site specific tree and grass species

Output 2.4 Sustainable conservation and co-management of forest areas demonstrated and JFM institutions strengthened for increasing their effectiveness in forest management

This activity incorporates the co-management system to improve the ecological status of degraded forest areas for the conservation of biological diversity and increasing carbon stock. Soil and water conservation measures are important components of regeneration and carbon sequestration. Strengthening of the JFM would be the other component of sustainable management of forests. A microplan would address intervention in forest areas focusing on the rehabilitation of degraded forest. Technologies for revegetation, forest regeneration/assisted regeneration, soil and water conservation will be demonstrated. Since an institutional mechanism to plan and manage activities is crucial to any intervention in forest areas, an institutional arrangement for social fencing will be introduced for protection of treated areas and a mechanism for sharing usufructs will be evolved. The activities will lead to following output:

2.4.1 Improvement in the ecological status of forest for biodiversity conservation and carbon sequestration

2.4.1.1 Create structures for water harvesting and soil conservation and maintain existing permanent ponds to assist natural regeneration in degraded areas.

2.4.1.2 Improvement in vegetative cover and enhancement of existing stock through assisted regeneration with emphasis on endemic species

2.4.1.3 Preparation of implementation plan for protection and conservation of identified endangered species

2.4.2 Strengthen the JFM institution for increasing its effectiveness in management of forests

2.4.2.1 Identify the factors critical to the success or failure of JFM experiments in semi-arid and arid regions

2.4.2.2 Advocate/build opinion for strengthening of JFM institutions based on above findings

2.4.2.3 Test models for a sustainable financing mechanism of management of lands under JFM

Output 2.5 Models for income generation identified and promoted

Intervention will augment the local community's income by identifying appropriate income-generating activities for individuals and at the community level.

2.5.1 Identify and promote linkages to sustain existing alternatives for income generation.

2.5.2 Promote a suitable credit and saving scheme to ensure sustainability of activities with special emphasis on women and weaker sections of society

2.5.3 Build the capacity of village institutions to ascertain and promote profitable community-based activities for sustainable micro projects

Immediate objective 3: To build capacity of stakeholders in IEM with specific reference to desert ecosystems.

Capacity-building of different stakeholders specially that of women and weaker sections involved in IEM is critical to the success of the programme. This will ensure their participation in the decision-making processes. To enable adaptive management locally, village communities will be trained in monitoring and evaluation. The expected output and activities towards achieving the objective are:

Output 3.1 Capacity of stakeholders built in IEM approach for combating desertification

The stakeholders will be trained to plan and manage their natural resources. Village level institutions will be trained to monitor and evaluate project activities. The activities that will be undertaken to achieve the output are

3.1.1 Training the village community in technical and management aspects of integrated land-use planning

3.1.2 Training in energy planning and awareness generation for demand side management and alternative sources

3.1.3 Building technical capacity among villagers to undertake monitoring and evaluation of biological resources

3.1.4 Building technical capacity of farmers in managing improved local breeds, poultry farming and bee keeping

3.1.5 Training in integrated ecosystem management approaches

Immediate Objective 4: To conduct monitoring and evaluation for biodiversity conservation and carbon sequestration

Periodic monitoring and evaluation are tools for the successful implementation and management of planned and implemented activities of a project. An inventory of the biodiversity status of animal and plants will also be prepared and updated periodically. This data will be converted into useful indices at the project implementation office. A database and framework for estimating carbon sequestration will be developed at the project implementation office. The expected output and activities towards achieving the objective are given below:

Output 4.1 Inventory of biodiversity status and traditional knowledge developed

Such an inventory will be developed through a participatory approach. A data bank on traditional knowledge for the management of CARs, pastureland and forestland would also be prepared. The following activities will achieve the output:

4.1.1 Prepare an inventory of animal and plant species and develop a databank through participatory approach

4.1.2 Document traditional knowledge of resource management in desert areas

Output 4.2 Participatory monitoring of project activities on CARs, private lands and JFM areas in place

4.2.1. Develop a participatory monitoring mechanism in 73 selected villages

4.2.2. Develop reporting format and record-keeping system of planned project activities

Output 4.3 Mid-term evaluation of project activities and adaptive management enabled

4.3.1 Analysis of progress and impact of project activities

4.3.2 Amendment of the project activities as per the recommendations of evaluation reports

Output 4.4 Database for estimating carbon sequestration in all project sites developed

4.4.1 Develop framework for database

4.4.2 Compile and update database every year for carbon sequestration

Immediate objective 5: To develop and operationalize an extension strategy to facilitate dissemination and replication of IEM approach for combating desertification

The project aims to disseminate the information, knowledge and lessons learnt from the project to other areas of these two provinces for facilitating replication of the IEM approach. An extension strategy including an enabling institutional mechanism will be established for flow of information to all the stakeholders.

Output 5.1 Institutional mechanism for continual information dissemination on land resource management and related aspects developed

5.1.1 Develop institutional mechanism of information flow on land resource management

5.1.2 Analysis and preparation of strategy for information flow and institutional structure

Output 5.2 Packages for replication of IEM based on the demonstration models for combating desertification prepared

Successful models of intervention and project leaning will be documented and finally, packages on IEM to rehabilitate arid and semi arid areas of western India would be prepared. Global benefits in the form of carbon sequestration and biodiversity conservation would also be documented for the benefit of all stakeholders. The activities that will be undertaken to achieve the desired output are:

5.2.1 Document experience of development of institutional design of CARs

5.2.2 Cost-benefit analysis of interventions for development of CARs

5.2.3 Document the process of developing and implementing participatory monitoring and evaluation mechanism

5.2.4 Document successful models of IEM on private lands among farmers

5.2.5 Document successful interventions in managing salt-and sand-affected lands

Output 5.3 Dissemination of extension packages and development of web-site

In addition to the long-term strategy for information dissemination, short-term and immediate measures will also be undertaken to disseminate the concept. The measures include organizing workshops, meetings, awareness camps for the stakeholders, conducting exposure visits to the project sites. Information will also be disseminated by TV, radio, local newspapers etc. A web-site will also be developed for easy access. The project will also bring out newsletters containing technical information about various models implemented. The activities that will be undertaken are:

5.3.1. Organization of workshops/seminars to discuss and disseminate project learning, outcomes and impacts

5.3.2. Establishment of regular networks for exchange visits and dissemination

5.3.3. Development and hosting of web-site

5.3.4. Distribution of pamphlets/brochures

RISKS, SUSTAINABILITY AND REPLICABILITY

47. The assumptions made and the consequent risks are provided in the logical framework. The major risks are associated with instability in climate and recurrent drought but these assumed to be favorable during the project period. Droughts are known to affect this region regularly about 4 every 10 years. The project is designed take account of these effects. Instability may also occur due to unforeseen political factors, either at the sub regional, or state level. However, the government is keen to reform its legal and policy framework, and has renewed the push to greater decentralization and devolution of authority to the lowest feasible levels. Such risks could be mitigated through mobilization of initiatives from local communities, line departments and other stakeholders to ensure that the desired outcome is achieved. The proposed project involves collaboration with various line departments and agencies as well as participation of local communities. However, the innovative approach adopted in this project will encourage harmony between organizations through state and district level committees.

48. Various designs have been incorporated to ensure sustainability of the project. The support of state governments is evidenced by their substantial budgetary contribution, dedication to tackling the problem of desertification and leadership in developing partnership

with bilateral donor agencies, which is a major and necessary ingredient for ensuring sustainability for the long term. Socio-economic sustainability will be enhanced with the promotion of appropriate techniques to generate sustainable income and establish rules for sustainable management of CARs, pastureland and forest areas. The project will demonstrate appropriate mechanisms for consultation, cooperation and equitable sharing of the profit from the protection and conservation CARs, forest areas and pasturelands. Participatory planning and management design will help to ensure adherence to good management rules. Thus overgrazing and overexploitation will be better controlled because of better incentives and consequent enforcement of rules in village institutions and communities.

49. It will be ensured by the village institutions themselves or by the implementing agencies capable of generating profit from sustainable use of renewable natural resources. The main assumptions of the project are that the investment in designated forest areas and involvement of village institutions in the protection and management of the forest will result in self-reliance in these areas, through more efficient budget allocations and financial sustainability.

50. Institutional sustainability will be assured through capacity-building of village institutions, members of the community, farmers, NGOs, trainers, forest managers and the related institutions involved in programme of combating desertification. The state governments of Rajasthan and Gujarat, communities and the NGOs acting at grass root level, will assume recurrent costs and will ensure the contribution of the activities in the post-project phase independently. The design of the project is based on testing, demonstrating models for replication and preparing the enabling environment for such replication in arid and semi-arid regions of Rajasthan and Gujarat. In addition it is expected that the lessons learnt from this project will contribute to our understanding of IEM and community-based protection, conservation of biodiversity and increased carbon sequestration in this highly fragile environment.

STAKEHOLDER PARTICIPATION AND IMPLEMENTATION ARRANGEMENT

51. Stakeholder participation in the preparation and planning of this project was achieved during the project development process through a series of workshops organized in Rajasthan and Gujarat states involving state departments, NGOs, scientists, and farmers. Participatory Rural Appraisal (PRA) was organized in 73 villages, directly involving some 70 739 people including crop farmers, transhumance, livestock farmers, village leaders, foresters, and representatives of government entities. All of these stakeholders approved the approach and endorsed the project, recognizing its major innovation i.e. the active role they were given at all identification and formulation stages and the model of IEM. Stakeholders including individual villagers, NGOs, various village associations, state departments will continue to participate in the implementation of this project. They will be responsible for applying the approaches and carrying out the activities and will assume responsibility for and acquire ownership of the project and its impacts to ensure the sustainability of the activities undertaken in the post-project phase.

52. A Project Coordination Cell at the Arid Forest Research Institute (AFRI), Jodhpur an ICFRE Institute under the MoEF, will work as coordinating agency between the two states and provide platform for workshops, discussions as well as technical services to the project-executing agencies. The cell will interact on behalf of the two state nodal agencies, with the UNDP.

53. The project will be implemented through the State Forest Departments of Rajasthan and Gujarat with cooperation from other line departments such as agriculture, the Gujarat Land Development Corporation, soil conservation, horticulture, etc. The Chief Conservator of Forests, Jodhpur in Rajasthan and Gandhinagar in Gujarat will be the nodal persons for the execution of the project (Annex H). State level and district level committees comprising representatives from various government and non-governmental organizations will provide overall guidance to the project. The Steering Committee in both states will be responsible for overall policy guidance. The District Advisory Committee will provide technical and infrastructure support for the project activities.

54. Village institutions and locally-available NGOs will be the main actors at the village level. The project will not create any new institution but will rely on permanent existing structures (both public and civic) so as to ensure institutional sustainability.

PROJECT FINANCING

55. The total cost of the GEF alternative including the baseline is US $ 31,376,567

Project component budget (US $)

Sl No	Project component	Baseline Costs	GEF	Beneficiaries	Total Costs
1	A policy and legal framework adapted to participatory Integrated Ecosystem Management (IEM)	21 739	2 22 174	0	2 43 913
2	Demonstration of integrated development and management of land resources to increase productivity and carbon stock as well as livelihood of desert dwellers	1 03 78 440	1 35 44 568	30 71 439	2 69 94 447
3	Capacity building of stakeholders in IEM with specific context to desert ecosystem	13 043	3 72 687	0	3 85 730
4	Monitoring and evaluation for biodiversity conservation and carbon sequestration	0	5 08 696	0	5 08 696
5	Development and operationalisation of extension strategy to facilitate dissemination and replication of IEM approach for combating desertification	0	5 43 478	0	5 43 478
Project administration and developmental activities		25 80 738	1 19 565	0	27 00 303
Project Total Cost		1 29 93 960	1 53 11 168	30 71 439	3 13 76 567

MONITORING, EVALUATION AND DISSEMINATION

56. The monitoring and evaluation of the project will be done at several levels. This will entail participatory planning, monitoring and evaluation of efficiency of implementation and project achievements and obtaining necessary benchmark data done through both traditional and participatory approaches (Annex D). Monitoring the progress of the integrated development models for land resources, biodiversity status and carbon sequestration will be done (inventories, data base preparation) by competent organizations in collaboration with the local people for government as well as private lands. A participatory monitoring mechanism will also be set up on common access resources.

57. The Forest Departments of Gujarat and Rajasthan will be the nodal agency and periodically monitor various aspects of project implementation in their states. The nodal agencies will prepare reports periodically and present them to the Steering Committee and also share them with the GEF, UNDP and State Government. In addition to periodic project monitoring, mid-period and project end evaluation by external agencies is planned.

58. The project envisages enhancing the capacity of the local communities and authorities to monitor the vegetative and biodiversity status as well as carbon sequestration. They will be trained to monitor, analyze and report findings to their village committees as well as to the project authorities. Project staff and NGOs will be encouraged to disseminate information through the existing network and scientific journals. Supervision mission by UNDP-GEF and other formal evaluation will be conducted on need basis in order to gather and disseminate the lessons learnt.

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ANNEX A: INCREMENTAL COST ANALYSIS

BROAD DEVELOPMENT GOAL

The Tenth Five-Year Plan, adopted by the National Development Council, had accorded priority to agriculture and rural development with a view to generating adequate productive employment and eradication of poverty. It targets a growth rate of 8 per cent to double the per capita income by year 2012 and reduction in poverty by 15 percent point. It also lays stress on ensuring the environmental sustainability of the development process through social mobilization and participation of people at all levels.

In the agriculture sector the major constraints will be land and water. It is increasingly recognized that subsidy-led growth has affected the availability of resources for developing capital in the agriculture sector. The stress is on improving agriculture, research in technology dissemination, crop diversification and paying attention to animal husbandry. In the rural development programme the stress is on developing micro-finance and increasing the people's contribution to development funds at the village institution level.

The increasing local air pollution, degradation of water resources, degradation of land resources and continued stress on forests has brought into sharp focus environmental concerns, and the Ninth Five Year Plan stressed integrating environmental issues within the sectoral policies rather than viewing it as a separate sector. A number of acts and policies to address these issues are in place. The Tenth Five Year Plan has set a target of 25% forest tree cover by 2007 and 33% by year 2012. JFM has been initiated to involve the people in protecting and conserving forest and this movement is being further strengthened.

BASELINE

- The ecosystem in the arid and semi-arid is fragile.
- Land is an important resource in these areas for meeting the needs of people ranging from food, fuel and fodder to rear the livestock.
- In a fragile ecosystem the interdependence on the various land use types is very high.
- At Present the land-use types (forests, common/community lands, privately owned lands) as well as activities dependent on land, such rearing as livestock, are planned for and managed without concern for their impact on other landforms. The forest areas are managed by the state forest department, agricultural development on the private lands is under the department of agriculture, livestock planning is carried out by the department of animal husbandry, and the common/community property lands are managed by village bodies with either the department or the village governing bodies owning them. Planning at the state level integrates the work of these departments. Planning Commission sets the overall growth targets and these are than worked down the sectoral growth patterns. The environmental or resources management sectors are separately addressed and may or may not have a relationship with the impact of development on these sectors. The individual sectoral growth targets are then translated into investment proposals and development scheme outlays. Both the centre and state allocate development schemes as well as funds

for environmental and resource management based on five-year plans.

- The recognition that the need for fuel and fodder has put unsustainable demands on forests has led to attempts to prompt agro-forestry and social forestry to generate more fuel and fodder from agriculture and common lands. The promotion of agroforestry is the forest departments responsibility, whereas the agriculture departments responsibility is to increase crop production.

- There have been some attempts at integrating the people into the planning and management of the land resource to address the local requirements. Though this is restricted to protected forest areas. Another attempt at integrated rural planning at district level has been through watershed development schemes, whereby local development issues such as development of employment, irrigation facilities, drinking water facilities, education like anganvadi etc. The forest department too, is making attempts to provide some integration at a local level by channelling resources through the Forest Development Corporation, but even these schemes are aimed at primarily forest areas or in some cases common access land; private agricultural land is not brought under the preview. In watershed development schemes however, the people's participation has been attempted. Some schemes which address the drought-proneness of the area, soil conservation measures, and fuel and fodder needs of the area are: Wasteland Development Programme (WDP); Drought Prone Area Programme (DPAP), Desert Development Programme (DDP), Watershed development Programme on cluster basis, Forestry Development Programme (FDP), Combating desertification (SEAP), reclamation of alkali soils, drought proofing plan (UNDP, Prime Minister fund, JRY, SJY), grassland development (JBIC, BADP) and land development programmes (World Bank, DRDA) etc. with special emphasis on improving the economic condition of desert dwellers.

- The resources for most of these developments is made available through the respective government agencies. There is a small contribution (usually a contribution of labour) by the beneficiaries. The resource planning is from top-bottom rather than bottom-top, which is primarily governed by limits on the availability of resources. This implies that the coverage of the area is being carried out at a slower pace than is required.

- There have been no attempts to encourage contribution by the locals based on the benefits that flow to them. This is also hindered by access to funds. NABARD does have schemes under which funds can be made available and it also operates through some commercial banks but there is a lack of evaluation within the banks and it is also difficult for the locals to prepare proposals to access funds.

- The other major constraint is the capacity at the village levels to plan and manage the use of resources. An important ingredient of such planning and management is the access to information about what alternatives for meeting their needs and the adverse impact of various land use types. This is partially due to the failure of integrated planning and partly, research, but more importantly, the failure of effective extension services.

- This is also true of the infrastructure required to manage the resources these aspects are inadequately stressed in the development projects. The support infrastructure is generally planned independently of the developmental activities. For example the department of Animal Husbandry promotes the use of livestock with greater but productivity supportive infrastructure in the forms of health care and artificial insemination is not adequately planned for. Similarly, there are various schemes funded by the union, state governments and external multilateral funding agencies focusing on wasteland development, the drought-proneness of the area, soil conservation measures etc. However, the approach is not is not integrated or multidisciplinary approach, the knowledge scattered, an absence of participation by the people and the lack of on the spot treatment to control desertification have led to only limited success.

GLOBAL ENVIRONMENTAL OBJECTIVE

Sector-based planning and the failure of integration on all issues of land use management have resulted in degradation of land resources due to increased population pressure. This has resulted in three major impacts. One, overexploitation of biomass from various land units has resulted in a decline of cover and resultant land degradation due to climatic factors. This has increased the desertification of the area and also the vulnerability to desertification. Two, the available biomass and the capacity to grow it from the land has decreased over the years. Three, the resultant degradation has resulted in loss of a number of flora and faunal species.

The proposed alternative to the existing way of land resource planning, management and use s primarily aimed at arresting land degradation and reducing the threat of desertification. The associated objective is to increase carbon sequestration by facilitating an increase in biomass density on various land units through integrated planning. The project also aims at conserving and preserving various land races of flora and fauna, which are under threat due to adverse ecological impacts.

GEF PROJECT OBJECTIVES

The overall objective of the of the GEF alternative is to promote Integrated Ecosystem Management in seven eco-zones categorized on the basis of wasteland in Rajasthan and Gujarat to generate global benefits from enhanced biodiversity conservation and carbon sequestration. The national and local level benefits are from sustainable use and equitable sharing of benefits. The alternative model will be tested in 11 representative sites in the arid and semi-arid areas of northwestern India and will be complemented by upstream activities in policy reform, capacity-building and monitoring.

The model adopted by the project will integrate a series of co-managed conservation, community-based natural resources management, local land-use planning and sustainable harvesting activities into an integrated manner based on the IEM principle. The three most mportant land units in these fragile ecosystems are forestland, common land and private and. The present project will demonstrate mechanisms for the integrated management and planning of these three land resource units to meet the development needs of the population. n addition, the regional interlinks between the seven eco-zones will be taken into account by ncremental eco-regional planning, where IEM and bio-regional issue are incorporated into egional planning, and provide the overall framework for integrated conservation and development planning at the local and regional levels. Each of the project's 11 representative andscapes contains three different but integrated spatial units. These units and the activities hat will be targeted selectively are:

Forest areas: The project will build on the baseline, by filling gaps in infrastructure, as well as capacity-building of forestry staff in eco-regional planning, forest area management and participatory forest management and regeneration. In addition, the projects will build institutions and capacity for co-management with local communities. Finally the protected area's capacity to generate revenue for covering recurrent costs will be strengthened.

Community land area: The project will encourage and build capacity for the sustainable management of community land resources following eco- regional principle's to reduce the pressure on forests area grazing and fuel wood collection. About 50 such community lands will be identified during discussions with the local stakeholders. Communal management and control of community lands, appropriate sustainable harvesting related to fuel and fodder, links to forest areas management, rehabilitation of degraded areas, and access to credit and saving, are all issues requiring attention. It will enhance biodiversity protection in the core zone. Rehabilitation and reforestation will result in a significant amount of carbon sequestration.

Farmers' field: This supports alternative technologies for low external-input and intensification of agriculture (crops and livestock) with a suitable model of agroforestry. It will supplement the supply of fuel wood and secure productivity in this highly fragile environment. Agricultural intensification is expected to reduce emissions of carbon from the land and the introduction of multipurpose trees into the agricultural fields will increase the carbon stock.

As identified earlier the lack of integrated planning at all levels, over-dependence on government funds for undertaking land management and better resource use techniques, lack of effective extension services and information, are the barriers we expect to lift through GEF funding. The project at the regional level will promote integrated eco-regional planning to rationalize land use and IEM. It will also build capacity among officials to integrate people into planning at the local level as well as build capacity among the local population to participate in integrated planning. Further, the project will address the main issue of access to credit to cover the resource gap felt by governments in increasing the effectiveness of their interventions.

GLOBAL ENVIRONMENTAL BENEFITS

The project will result in increase of biomass density on all the three important land use types as well as conserve and protect the important floral and faunal species. The impacts of project are estimated at three levels; on the areas covered under the immediate project, the demonstration affect on the village areas where these models are demonstrated and the impact of the project on the area threatened by land degradation and desertification.

i) **Carbon Sequestration**: The estimated carbon benefits are reported in Table 1 below. The estimates are based on actual survey-based estimates of existing biomass density and soil carbon on different land units and data reported in literature on biomass density and soil carbon in areas that are managed in good health.

Land Type	Area for treatment in the project (ha)	Land at project Site (ha)	Total land in Rajasthan and Gujarat (mha)	Changes in biomass carbon (tonne/ hectare)	Carbon sequestration on treated land (million tonnes)	Carbon sequestration possible on land at site (million tonnes)	Potential for C sequestration (m tonnes)
Degraded forest	3550	9153.14	1.8	13.1	0.05	0.12	23.58
Gully and ravines	2030	5561.45	0.6	9.025	0.02	0.05	5.42
Scrub land	1560	12801.00	4.9	11.88	0.02	0.15	58.21
Salt land	5765	56346.64	1.04	3.71	0.02	0.21	3.86
Pasture land	10715	68642.94	1.26	8.95	0.10	0.61	11.28
Desertic /sand dune	2300	30238.00	4.08	9.175	0.02	0.28	37.43
Rocky / hummocks	2990	20378.00	0.81	6.985	0.02	0.14	5.66
Total	28910	203121.17	14.49		0.24	1.57	145.43

(i) Biodiversity conservation:

Within the semi-arid and arid expanse of the project area, five distinguishable eco-regions have been identified for biodiversity conservation. Grasslands, the Velabadar and Banni grasslands of central Saurastra and Kutch respectively of Gujarat (once the largest grassland in Asia) and *Lasiurus sindicus-Elusin compressa* grassland of Western Rajasthan, were dominated by *Daicanthium-Cenchrus-Lasiurus*. The *Lasiurus sindicus - Elusine compressa* is being slowly replaced by *Aristida funiculata–Dactyloctenium sindicum* grasses with a concomitant decline in basal cover and plant density (Shankarnarayan and Kumar, 1987). Similarly, the permanent pastures and fallow which once supported a good stand of trees/ shrubs and grasses have been invaded by *Posopis juliflora, Crotalaria burhia* and *Aristida fumuculat*, leading to a decline in productivity. The degraded forestlands in the Aravalli hills were dominated by *Anogeissus pendula* in all age classes. The common grass species of the area are *Themada triandra, Diacanthium annulatum, Heteropogon contortus, Sorghum halepense, etc.* The saline areas of the Rann fringe support saline herbaceous vegetation i.e. *Suaeda spp., Salvadora spp., Capparis spp., Calotropis procera* and a variety of grasses. *Prosopis juliflora* is the dominant species and has invaded these areas suppressing local flora. The scrubland, where the land either is waste or Gauchar land. The forests of this region are classified as mixed dry deciduous and thorny forests. *Acacia auriculata* is found in abundance in wasteland and Gauchar land . Danda thor (*Euphorbia spp.)*, Guggal (*C. wightii)* is found on the hilly areas but in low abundance. Among the grasses, common species are *Aristida spp., Eragrostis spp., Chloris spp.,* and *Aeluropis spp.* Most of these species are threatened and the technological package in each eco-region uses these local species for propagating agro-silvi-pastoral land management to increase the availability of biomass. The project intervention will demonstrate the resilience of the proposed mix of species to the typical climatic conditions of these zones as well as their economic viability. The effort is likely to lead to two impacts, one decreased pressure on the forest areas, two, proper maintenance of the common lands. This in turn will decrease the pressure on vegetative species and preserve the floral biodiversity of the area.

DETAILED COSTS

The GEF increment will build upon the baseline and co-financing, to cover the additional costs related to achieve global benefits.

1 The GEF increment will cover the costs of developing, testing and demonstrating the integrated conservation/development and eco-regional planning models in a few selected sites in each of the 11 eco-zones.

2 The funding to address areas under forests will cover the incremental costs over and above the cost norms for forest regeneration activities under taken by the forest department. The regeneration and conservation model being demonstrated integrates soil and water conservation techniques too, which are normally not addressed in departmental activities.

3 The demonstration of sand dune stabilization and salt-infested land reclamation be through models tested in the field but which are not familiar to the people and therefore have a perceived risk associated with it. The co-financing will cover the cost of routine models; and the labour will be contributed by the local population.

4 For demonstration activities aimed at private agricultural lands a major fraction of the cost is being requested from GEF in the form of a revolving fund. Given the lack of familiarity with these models and the reluctance of farmers to take risks, it is unlikely that they will be willing to incur cash costs until the benefits are demonstrable. The co-financing will cover the cost of providing seedlings and labour.

5 On common access land at present government schemes provide funds for plantation activities alone. The present model being demonstrated integrates soil and moisture conservation components as well as a move away from a plantation to a silvi-pastoral model. The incremental cost over and above the plantation costs will be covered through GEF grants. Though these activities will lead to direct benefits to the local population an actual demonstration of the benefits accrued and the possibility of generating resources privately to manage these lands is important it decreasing the dependence on the government for resource management.

6 The GEF increment will also lift the barriers to the sustainability and replicability of the integrated conservation and development and sustainable eco-regional models. These barriers are technical, economic, political and institutional by nature. The GEF increment will address these barriers at the local and regional level in the form of appropriate technologies, institution-building, economic incentives, capacity-building, inter sectoral policy reform and legal clarification.

Tabel 2 The incremental costs in US $

Sl No	Output	Total Costs	Baseline Costs	Community	GEF
1.1	Identification of legal and policy obstacles in adoption of IEM for combating desertification and advocacy of appropriate measures	1 09 130	0	0	1 09 130
1.2	Documentation of local traditional management systems of CARs and strengthening of community-based institutional arrangement for its sustainable management	73 913	13 043	0	60 870
1.3	Identification and advocacy of institutional mechanism for integration of sectoral issues among various line departments for planning and implementation of IEM	60 870	8 696	0	52 174
2.1	Demonstration of sustainable land development models including soil and moisture conservation measures on agricultural land through intensive and diversified production systems	29 68 567	6 15 332	8 38 584	15 14 651
2.2	Demonstration of sustainable land development models to reclaim salt and sand-affected land	1 12 31 772	4492709	1123177	5615886
2.3	Demonstration of conservation and sustainable management of CARs and pasturelands	1 04 64 391	41 93 583	10 38 613	52 32 195
2.4	Demonstration of sustainable conservation and co-management of forest areas and strengthening of JFM institutions for increasing its effectiveness in forest management	22 16 674	10 65 946	71 065	10 79 663
2.5	Identification of models for income generation	1 13 043	1 0870	0	1 02 173
3.1	Capacity building of stakeholders in IEM approach for combating desertification	3 85 730	13 043	0	3 72 687

Sl No	Output	Total Costs	Baseline Costs	Community	GEF
4.1	Development of Inventory on biodiversity status and traditional knowledge	30 435	0	0	30 435
4.2	Participatory monitoring of project activities on CARs, private lands and JFM areas in place	65 217	0	0	65 217
4.3	Mid term evaluation of project activities and adaptive management	86 957	0	0	86 957
4.4	Database creation for estimating carbon sequestration in all project sites	3 26 087	0	0	3 26 087
5.1	Development of institutional mechanism for continual information dissemination on land resource management and related aspects	65 217	0	0	65 217
5.2	Preparation of packages for replication of IEM based on the demonstration models for combating desertification	2 60 870	0	0	2 60 870
5.3	Dissemination of extension packages and hosting of web site	2 17 391	0	0	2 17 391
Project Administration and Developmental Activities		27 00 303	25 80 738	0	1 19 565
Total project cost		**3 13 76 567**	**1 29 93 960**	**30 71 439**	**1 53 11 168**

ANNEXURE B: PROJECT ACTIVITES AND FINANCING PLAN

Activities	Financing arrangement
1.1 Identification of legal and policy obstacles in adoption of IEM for combating desertification and advocacy of appropriate measures	
1.1.1 Identify legal and policy constraints for rehabilitation of CARs and suggest remedial measures	GEF
1.1.2 Identify legal and policy constraints in integrated management of private lands resources and suggest remedial measures	GEF
1.1.3 Advocacy/opinion-building of recommended policy and legal measures for rehabilitation CARs.	GEF
1.1.4 Advocacy/opinion-building of recommended policy and legal measures to encourage integrated management on private and community lands	GEF
1.2 Documentation of local traditional management systems of CARs and strengthening of community-based institutional arrangement for its sustainable management	
1.2.1 Document traditional management systems adopted by existing village institutions for management of CARs	GEF
1.2.2 Identify and promote measures to strengthen community based institutional arrangement for sustainable management and development of CARs	GEF and State Governments
1.3 Identification and advocacy of institutional mechanism for integration of sectoral issues among various line departments for planning and implementation of IEM	
1.3.1 Identify legal and policy constraints among various line departments and suggest measures to integrate them	GEF
1.3.2 Advocacy for integration of sectoral issues among various line departments	GEF
2.1 Demonstration of sustainable land development models including soil and moisture conservation measures on agricultural land through intensive and diversified production system	
2.1.1 Demonstrate, promote and replicate field bunding and live hedges and other site-specific activities for soil and water conservation	GEF, state government and beneficiaries
2.1.2 Demonstrate and promote agri-silviculture models on agricultural lands	GEF, state government and beneficiaries

Activities	**Financing arrangement**
2.1.3 Identify incentive structures for promotion of agri-silvicultural practices	GEF
2.14 Demonstrate and promote agri-horticultural models on agriculture lands	GEF, state government and beneficiaries
2.1.5 Demonstrate nursery development for multipurpose tree species and horticultural species	GEF, state government and beneficiaries
2.1.6 Provide technical assistance in adopting local improved breed cattle, goats, poultry farming and bee keeping	GEF and state government
2.1.7 Organize livestock health monitoring and training camps	GEF and state government
2.2 Demonstration of sustainable land development models to reclaim salt-and sand-affected land	
2.2.1 Demonstrate techniques to stabilize sand dunes, ravines and rocky hummocks for habitat improvement and income diversification	GEF, state government and beneficiaries
2.2.2 Demonstrate techniques to reclaim saline soils for productivity enhancement	GEF, state government and beneficiaries
2.3 Demonstration of conservation and sustainable management of CARs and pasturelands	
2.3.1 Develop participatory plan for management of CARs for increased biomass production and promote alternate energy sources	
2.3.1.1 Develop microplans for management of CARs based on the needs of village community (including nomadic groups) and its carrying capacity	GEF and state government
2.3.1.2 Develop village energy plans incorporating demand side management of wood and alternative energy sources	GEF and state government
2.3.1.3 Identify and promote measures to strengthen accesses and enforcement rules of good management of CARs including fines for infractions at village/panchayat level	GEF and state government
2.3.1.4 Establish and manage mechanisms for self financing of CAR management such as through use fees and sale of products	GEF and state government
2.3.2 Site specific silvi-pastoral models for sustainable use regimes on CARs	
2.3.2.1 Soil and water conservation based on the topography of the site to improve productivity of land resource	GEF, state government and beneficiaries
2.3.2.2 Establishment and management of 210 ha grass seed production areas	GEF, state government and beneficiaries

Activities	**Financing arrangement**
2.3.2.3 Re-vegetation of CARs with site specific trees and grass species	GEF, state government and beneficiaries
2.4 Demonstration of sustainable conservation and co-management of forest areas and strengthening of JFM institutions for increasing its effectiveness in forest management	
2.4.1 Improvement in ecological status of forest for biodiversity conservation and carbon sequestration	
2.4.1.1 Create structures for water harvesting and soil conservation and maintain existing permanent ponds to assist natural regeneration in degraded areas.	GEF, state government and beneficiaries
2.4.1.2 Improvement in vegetation cover and enhancement of existing stock through assisted regeneration with emphasis on endemic species	GEF and state government
2.4.1.3 Preparation of implementation plan for protection and conservation of identified endangered species	GEF and state government
2.4.2 Strengthen the JFM institution for increasing its effectiveness in management of forests	
2.4.2.1 Identify the factors critical to the success or failure of JFM experiment in semi-arid and arid regions	GEF
2.4.2.2 Advocacy/Opinion-building for strengthening of JFM institutions based on above findings	GEF and state government
2.4.2.3 Test models for sustainable financing mechanism of management of lands under JFM	GEF
2.5 Identification of models for income-generation	
2.5.1 Identify and promote linkages for sustainability of existing income-generation alternatives	GEF and state government
2.5.2 Promote suitable credit and saving scheme to ensure sustainability of activities with special emphasis on women and weaker section of society	GEF
2.5.3 Built capacity of village institutions to ascertain and promote profitable community-based activities for sustainable micro projects	GEF
3.1 Capacity building of stakeholders in IEM approach for combating desertification	
3.1.1 Training village community in technical and management aspects of integrated land use planning	GEF
3.1.2 Training in energy planning and awareness generation for demand side management and alternative sources	GEF
3.1.3 Building technical capacity among villagers to undertake monitoring and evaluation of biological resources	GEF
3.1.4 Building technical capacity of farmers in managing improved local breeds, poultry farming and bee	GEF

Activities	Financing arrangement
keeping	
3.1.5 Training in integrated ecosystem management approaches	GEF
4.1 Development of inventory on biodiversity status and traditional knowledge	
4.1.1 Prepare an inventory of animal and plant species and develop databank through participatory approach	GEF
4.1.2 Document traditional knowledge of resource management in desert areas	GEF
4.2 Participatory monitoring of project activities on CARs, private lands and JFM areas in place	
4.2.1 Develop a participatory monitoring mechanism in 72 selected villages	GEF
4.2.2 Develop reporting format and record keeping system of planned project activities	GEF
4.3 Mid-term evaluation of project activities and adaptive management enabled	
4.3.1 Analysis of progress and impact of project activities	GEF
4.3.2 Amendment of the project activities as per the recommendations of evaluation reports	GEF
4.4 Database creation for estimating carbon sequestration in all project sites	
4.4.1. Develop a framework for database	GEF
4.4.2. Compile and update database every year for carbon sequestration	GEF
5.1 Development of institutional mechanism for continual information dissemination on land resource management and related aspects	
5.1.1 Develop institutional mechanism of information flow on land resource management	GEF
5.1.2 Analysis and preparation of strategy for information flow and institutional structure	GEF
5.2 Preparation of packages for replication of IEM based on the demonstration models for combating desertification	
5.2.1 Documentation of the experience of development of institutional design of CARs	GEF
5.2.2. Cost benefit analysis of interventions for development of CARs	GEF
5.2.3 Documentation of the process of developing and implementing participatory monitoring and evaluation mechanism	GEF
5.2.4 Documentation and dissemination of successful models of IEM on private lands among farmers	GEF
5.2.5 Documentation of successful interventions in managing salt-and sand-affected lands	GEF

Activities	Financing arrangement
5.3 Dissemination of extension packages and hosting of web site	
5.3.1 Regular networking and exchange visit to project sites	GEF
5.3.2 Workshop/Seminars for dissemination of project achievements	GEF
5.3.3 Development and hosting of web site	GEF
5.3.4 Preparation and distribution of pamphlets/brochures	GEF
Project administration and developmental activities	GEF and State Government

ANNEXURE C - LOGICAL FRAMEWORK ANALYSIS

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
Global objective: Conservation and sustainable use of globally significant biodiversity and enhancement carbon sequestration in seven representative eco-zones in arid and semi arid areas of western India	• Significant change in biological diversity in these highly fragile area (i.e. increase in species richness and abundance) over baseline scenario • 20-30% increase in amount of carbon sequestered over baseline scenario by assimilation in standing biomass and soil by Y5	• Participatory monitoring and evaluation report • Estimates of carbon stock and database prepared	• Timely policy support by the government for IEM approach • Macro-economic stability • Ensured participatory approach • Current pattern of rainfall continue to be good or improves
Specific objective: Improve local environment through application of IEM approach for optimizing land utilization, reducing land degradation and ensuring sustainable livelihood to the desert dwellers.	• 25% increase in biomass in forest and scrubland, 15% in CARs, 20% in sand and salt affected lands and 10% in agricultural land over baseline scenario by Y5 • 20-30% increase in soil carbon content over baseline scenario by Y5 • Reduction in grazing pressure on forest areas • Significant change in ground cover and reduction in soil erosion by Y5 • Enhanced income for 50 % households through interventions by Y5	• Participatory monitoring and evaluation reports • Soil analysis data in different eco-zone and sample estimates. • Survey reports and direct observations • Departmental records for forest offences • Sample household survey	
Immediate objective 1: To identify policy, legal and institutional barriers in adoption of IEM for combating desertification and advocate appropriate measures	• Reports on policy and legal obstacles prepared by Y1 • Policy makers and Opinion building workshops organized by Y1	• Policy report • Workshop proceedings	• The current policy and legal mechanism are not entirely conducive for IEM approach • The government respond positively to the recommendations

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
Output 1.1 Legal and policy obstacles in adoption of IEM for combating desertification identified and advocated	• Identification of legal and policy constraints in rehabilitation of CARs and wastelands completed by Y1 • Identification of legal and policy constraints in integrated management of private land completed by Y1 • Seven opinion building workshop organized by Y1.5	• Study report • Study report • Workshop proceedings	
Output 1.2· Local traditional management systems of CARs documented and community based institutional arrangement strengthened	• Knowledge on local traditional management system of CARs documented by Y1.5 • 73 number of village level committees formed by Y1 • Identification and strengthening of community based institutional arrangement for sustainable management and development of CARs in place by Y3	• Direct observation • Focus group discussion • Sample survey	• Community members respond positively
Output 1.3: Institutional mechanism for promoting integration of sectoral issues among various line departments for planning and implementation of IEM identified and advocated	• Legal and policy constraint for implementation of IEM among various line departments identified and documented by Y 1.5 • Eleven local advocacy meetings for integration of sectoral issues organized by Y1.5	• Study report • Discussion with line departments • Direct observation	• Government and Line departments respond favorably to institutional re-orientation
Immediate objective 2: To demonstrate IEM models to increase productivity and carbon stock as well as the livelihood status of desert dwellers	• Demonstration trials established in seven eco-zone and 11 sites of both the states to increase biodiversity and productivity through plantation, resource management, disease and pest control measures by Y5	• Direct observation, group discussion and sample household survey • Ground verification • External project audit • Annual inspection	• Adequate institutional development and capacity development preceded

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
		reports	
Output 2.1: *Sustainable land development models including soil and moisture conservation measures on agricultural land demonstrated and income diversification promoted.*	- Beneficiaries identified by Y 1.5 for intervention in livestock, poultry and bee keeping sector - Demonstrated bee keeping and poultry farming to the interested beneficiaries by Y2 - Demonstrated stall feeding for sheep and goat fattening by Y5 - 10% households with improved cattle by Y5 - 72 number of village nursery developed for multipurpose/ horticultural species by Y2 - 7,065 ha of agriculture land treated by adopting live hedge, agri-silvi and agri-horti models through introduction of trees, shrubs and horticultural plants as well as grasses/medicinal plants by Y4 - 20 % increase in fodder and fuel wood availability (over baseline scenario) by Y5 - 10-20% increase in agricultural land productivity by Y5 - Eleven livestock monitoring and training camps organized byY4	- Activities records with project implementation office - Direct observation - Focus group discussion and sample household survey	- Adoption of technological packages by the community - Inter-sectoral coordination at the site
Output 2.2: *Sustainable land development models to reclaim salt and sand affected land demonstrated*	- Micro-plans prepared for intervention of sand and salt affected lands by Y 1.5 - 4825 ha area treated for salt land management to increase biodiversity and biomass productivity by Y4 - Demonstrated sand drift control/ sandy hummocks in 2920 ha to increase productivity of highly stressed site with preference to indigenous species - Demonstration on 670 ha of land to recover gullies/	- Micro-plan records - Direct observations - Data recorded	- Adoption of technological packages by the community - Pattern of rainfall improve

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
	ravines to improve productivity and biodiversity • 10-20% increase in fodder availability by Y 5 over base line scenario • 30-40% increase in carbon stock by Y5 above baseline		
Output 2.3 Sustainable management of CARs and pastureland demonstrated	• Micro-plan to rehabilitate the CARs and pasturelands prepared by Y2 • Village energy plan developed and villagers promoted to use alternate energy sources by Y2 • Management plan and self financing mechanism for CARs management at place by Y3 • 3860 ha areas of CARs rehabilitated to increase biodiversity and productivity by Y5 • 210 ha grass seed production areas developed by Y3 • 7560 ha pastureland rehabilitated with improved grass varieties and multipurpose tree/ shrub species • 50% increase in fodder availability in the activities area over base line scenario	• Group discussion • Direct observations • Sample survey • Micro-plan draft • Group discussion • Direct observations	• Community and village institutions respond favorably

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
Output 2.4 Sustainable conservation and co-management of forest areas demonstrated and JFM institutions strengthened for increasing its effectiveness in forest management	• Developed micro-plan for integrated management of degraded forest and scrubland by Y 1.5 • Demonstrated eco-rehabilitation/ regeneration of degraded forest and scrubland in 2010 ha areas by Y1.5 • Conserved and assisted regeneration of less available plant species by Y 5 • 20-30% increase in fodder availability over the base line by Y 5 • Significant improvement in biodiversity by Y5 • 30-40% increase in carbon stock by Y5 • Documented factors/ constraints for success and failure of JFM in dry areas by Y2 • Build opinion and awareness to strengthen JFM to rehabilitate the degraded forest and scrubland in dry areas by Y 2	• Study report • Group discussion • Micro-plan and records of the project • Direct observation • Sample estimated	
***Output 2.5**: Models for income generation identified and promoted*	• Developed and promoted linkages with institutions for market information about the village produce by Y3 • Trained village institution to promote income generation activities by Y 3 • Initiation of suitable credit and saving scheme to ensure income generation activities by Y1 • Promotion of income generation activities for women and weaker section of society to augment their income and participate in decision making by Y 5	• Study report • Direct observation • Sample survey	• Sufficient production of horticulture produce, honey, medicinal plants. • Adequate Govt. support

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
Immediate objective 3: To build capacity of stakeholders and institutions in IEM with specific context to desert ecosystem	• Organized training to the institutions and the beneficiaries to run the project effectively and achieve the global as well as the local benefits	• Group discussions • House hold survey	
***Output 3.1:** Capacity building of beneficiaries, village institutions and line departments in IEM approach for combating desertification*	• 15 training on micro-planning organized for village community by Y1.5 • 26 training on institutional governance, energy planning, monitoring and evaluation organized by Y 2.5 • 12 training organized on various GEF interventions for beneficiaries by Y2 • Training to village institutions to manage improved breed, poultry farming and bee keeping by Y 3 • Six training of trainers on micro-planning organized by Y1 • Technical training for agroforestry/ salt land management and resource management organized by Y2.5 • Some NGOs trained on information sourcing and networking for IEM approach by Y1	• Training reports, feed back forms and records with project implementation office • Different manuals prepared on project activities.	

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
Immediate Objective 4: To conduct monitoring and evaluation for biodiversity conservation and carbon sequestration	• Mid-course monitoring conducted to correct the shortcomings • Species enrichment and carbon sequestration monitored	• Physical verification • Group discussion • Records at the project implementation office	• Adequate capacity of village community built up to undertake monitoring, evaluation and documentation • People feel empowered in monitoring and evaluation
***Output 4.1**: Inventory on biodiversity status and traditional knowledge developed*	• Biological diversity inventory prepared by Y2 and updated every year thereafter • Documented traditional knowledge of resource management by Y2	• Direct observation, Focus Group Discussion, records at the project implementation office • Physical verification of monitoring repots	
***Output 4.2**: Participatory monitoring of project activities in place*	• Participatory monitoring mechanism in 72 village groups developed by Y1 • Monitoring report of implementation of planned project activities prepared by Y2 and then at intervals of one year	• Physical verification of inventory, documents at the Project implementation office	
Output 4.3: Mid term evaluation of project activities enabled Adaptive management enabled	• Results analyzed and corrections made by end of Y2.5	• Focus group discussion • Documents at project implementation office	
***Output 4.4:** Database for estimating carbon sequestration developed*	• Framework for database prepared by Y2 • Database compiled and updated every year starting from Y3	• Physical verification of data base • Documents at the Project implementation office	

Objectives/ strategy and output	Verifiable indicators	Means of verification	Critical assumptions
Immediate objective 5: To develop and operationalise extension strategy to facilitate dissemination and replication of IEM approach	• Strategy operational by Y5 and information dissemination as early as Y1	• Direct observation and records at project implementation office	• Support from other government departments in disseminating information
Output 5.1 Institutional mechanism for continuous information dissemination of land resource management and related aspects developed	• Present flow of information documented and institutional mechanism developed for information dissemination on land resources by Y4 • Extension strategy at place by Y5	• Physical verification of strategy document and tools	
Output 5.2 Packages for replication of IEM based on the demonstrations models for combating desertification prepared	• Documented the outcomes and impacts of interventions by Y5 • Documented the best model for further replication in the specific area by Y 5 • Audio-visual package prepared by Y5 • Prepared data base on carbon sequestration and biodiversity conservation	• Physical verification of packages and documents at project implementation office.	
Output 5.3 Dissemination of extension packages and development of web site	• Six workshops and fourteen initial and mid term meetings organized to disseminate project learning and packages by Y5 • Extent of coverage through mass media • Exposure visits organized for 12 groups to 11 sites in two states to establish regular networking Y5 onwards • Developed and host web site for easy access of information amongst the stakeholders	• Workshop proceedings and minutes of meetings • Clippings and records with the project implementation office • Documents at the project implementation office	

ANNEXURE D: BIOLOGICAL DIVERSITY AT THE PROJECT SITE

During the formulation of the strategy for combating desertification and its action plan there was a consensus over biodiversity conservation, reclamation of degraded areas through forest and pastureland management and combating desertification. The arid and semi-arid region is spread over 127.3 million ha area in India out of which 47 million ha lie in Rajasthan and Gujarat (93% and 78%), respectively, constituting more than 80% area of the Indian desert. Studies suggest that the root causes of land degradation and desertification are overgrazing of common access resources (CARs), pasture and forestland, overexploitation of vegetation, faulty agricultural practices, wind erosion resulting in sand drifts, quarrying and mining spoils, expansion of settlements and over-exploitation of groundwater.

DEGRADED FOREST LANDS

The site selected is located at the southern end of the Aravalli range in the Banaskantha and Sabarkantha districts of northeast Gujarat. 24 villages with a population density of 270 km^{-2} were surveyed. The area has a livestock density of 207 cattle km^{-2} in which the population of small ruminants has recorded a significant increase. The area is in a highly degraded state and sometimes totally devoid of any vegetation due to overgrazing/pollarding and illicit felling. The climate of the area is characterized by general dryness except during the brief monsoon season (average number of 25 rainy days) with an annual average precipitation of 734 mm. The forest is classified into hill forest and forests in valleys. The soils of the foothills are very shallow. The density of vegetation on the hill areas is sparse compared to that in the valleys. The predominant tree species in forest areas are *Boswellia serrata* and *Lannea grandis*, which constitute more than 20-30% of the growing stock. The middle portions of the hills are dominated by *Acacia catechu* and *Dalbergia latifolia*, which alone constitutes approximately 20% of the growing stock, whereas at the foothills, *Anogeissus pendula* predominates in all age classes. Common tree species of the top canopy are *Anogeissus latifolia, Salmalia malabarica, Mitragyana parvifolia, Dalbergia latifolia, Emblica officinalis, Terminalia bellerica, Tamarindus indica, Aegle marmelos, Diospyros melanxylon, Boswellia serrata, Lannea grandis, Albizia odorotissima, Grewia latifolia, Acacia catechu, Syzygium cumini and Ficus glomerata.* The middle canopy includes *Anogeissus pendula, Balanites roxburghii, Butea monosperma, Wrightia tinctoria, Cassia fistula, Emblica officinalis, Zizyphus jujuba,* and *Dendrocalamus strictus*. The lower canopy is composed of *Helicteres isora, Nyctanthus arbortristis, Alangium salvifolium, Zizyphus xylopyra, Capparis sepieria* and *Acacia jacquemontii.*

However, degraded forest areas have a very shallow soil depth, with SOC of 0.21% and are covered by surface spreading *A. pendula* and appeared to be due to grazing pressure. The area is covered by surface spread of *A. pendula* appeared due to grazing pressure. The dominant tree species are *A. leucophloea, A. tortilis* and *P. juliflora* with a population density of 34, 23 and 16 trees ha^{-1}. *Tectona grandis* and *D. strictus* are altogether absent from these areas. In CARs, *P. juliflora* and *A. tortilis* are the common species affecting grass production. Among the shrubs *Cassia auriculata, C. decidua, Z. nummularia* and *Calotropis gigantea* are the dominant species in forest, Gouchar and agricultural areas. Common herbs and grasses are *Aristida funiculata, Cassia tora* and *T. purpurea* where *Themada triandra, Dichanthium annulatum, Heteropogon contortus, Sorghum halepense, etc.* used to dominate. *Butea monosperma* and *A. nilotica* dominates in hilly areas and agricultural land respectively. A majority of the 63 families and 18 orders (450 species) found in Gujarat, were found in the area, but due to loss of forests, hunting and poaching, as well as mining, wildlife has practically disappeared.

The other area is Bugav in Jalore district of Rajasthan. It is a desert tract with isolated hillocks and rocky outcrops. The average elevation of the plains is about 180 m and the hills rise up to 736 m above mean sea level. Sandy tracts are the other feature in the area. The Jawai, Khari, Bandi and Sagi, tributaries of the Luni, constitute the drainage system. The climate of the district is dry with extremes of temperature and low rainfall. The forests of the area are of the central India mixed deciduous type and the bulk grows on the detached and isolated hill slopes. Area under designated forest is about 32% of the total area with a district population density of 74 km^{-2}. The two villages surveyed had an average population density of 76 km^{-2} and livestock density of 42 km^{-2}. The main feature of the areas is highly degraded hills with overgrazed and overexploited vegetation. Soil is almost negligible on hillocks but in agricultural farms the soil depth is sufficient will an SOC of 0.19%. *Acacia senegal, Balanites roxburghi, Boswellia serrata, Prosopis cineraria, Lannea coromandelica, Euphorbia nivulia*, and *Salvadora spp.* are the dominant species in the forests of hill slopes. Dominant tree species are *P. juliflora* (50%) and *A. pendula* (14%) followed by *A. senegal, Butea monosperma, Acacia leucophloea* etc. with a population density of 6 to 37 trees ha^{-1}. More or less the same distribution is found in CARs and agricultural lands. Common trees found in the forest along the base of the hills and in the plains are *Prosopis cineraria, Salvadora spp., Acacia leucophloea*. Among the shrubs *Cassia auriculata* and *Euphorbia nivulea* are the dominant species followed by *Zizyphus nummularia. Aristida haystris* and *T. pupurea* are the main herbs replacing *Cenchurus* sp. Wild animals found in the forest area are black bear (*Melursus usinus*), panther (*Panthera pardus*), jackal (*Cania aurnes*), indian fox (*Vulpes benagalensis*), chinkara (*Gazella bennnetii*) and, the house sparrow (*Passer domesticus*), bulbul, baya, parrot or rose ring parakeet, and koyal are birds commonly found in the area.

LAND WITH SCRUB AND ISOLATED TREES

The tract lies just near the Tropic of Cancer in districts Surendarnagar and Rajkot of Gujarat and has a tropical climate, which is generally dry but tends towards extreme. The average annual rainfall is 517 mm with an average number of 30 rainy days. The area forms a plateau surrounded by a chain of hillocks with a highest elevation of 358 msl. The region is generally deficient in water. Soils in the area are classified as brown and grey with a soil organic carbon of 0.22%. Rocky and gravelly surfaces are common in wasteland, Gauchar and forestlands. Agriculture is restricted to valley areas where a favourable soil depth is available. Forests lie scattered on undulating as well as flat areas with suitable soil depth. The trees stand far apart singly or in groups. Most villages have huge portion of wastelands and Gauchar lands, which are in an extremely degraded state. The forests of this region are classified as mixed dry deciduous and thorny. The vegetation in this area is dominated by *Acacia nilotica, Acacia jacquemontii, Acacia leucophloea, Acacia senegal, Acacia tortilis, Anogeissus latifolia, Azadirachta indica, Bauhinia racemosa, Butea parviflora, Cadaba fruticosa, Cryptistegia glandiflora, Grewia tenax, Helieteres isora, Maeuria arenaria, Prosopis cineraria, Prosopis juliflora, Salvadora persica, Sericostomma pauciflora, Vogelia indica, Balanites aegyptiaca, Calotropis procera, Capparis decidua, Cassia auriculata, Commiphora wightii, Crotalaria burhia, Dichrostachys nutans, Euphorbia caducifolia, Leptadenia pyrotechnica, Maytenus emarginata, Plumbago zeylanica, Rhus mysuriensis, Waltheria indica, Zizyphus numularia, Aristida depressa, Aristida hystrix, Alysicarpus spp., Arthraxon lensuratus, Blepharis linariaefolia, Convolvulus microphyllous, Cymbopagon* *martini, Cyprus spp., Dactyloctenium aegypticum, Dichoma tomentosa, Elusine spp., Eragastris cilliaris, Indigofera cordifolia, Indigofera liniflora, Merremia hederacea* and *Polycarpia coriambosa.*

GULLIES AND RAVINES

The western slopes of the Aravalli hills in and around the Siwana and Kundal range in Barmer district are beset by the problem of sandy ravine formation, the main form of land degradation in the region. The Aeolian deposition of a thick layer of sand on the hill slopes is susceptible to water erosion because of run off flow from the barren hillocks. Over-exploitation and destruction of vegetation on the hill slopes has aggravated the problem in the recent times. Ground water recharging has almost stopped because of this runoff and immediate attention is required for increasing productivity in this region. Sand movement and deposition also pose a threat to nearby agricultural fields. Soil is sandy loam with an SOC of 0.09%. The climate is typical of the arid zone with extremes of temperatures, low and erratic rainfall and high evaporative demand. The average annual rainfall in this region is 277 mm. The vegetation in the surveyed areas of Barmer is dominated by *Prosopis juliflora, Anogeissus pendula, M. emarginata, P. cineraria and Z. mauritiana* etc. with a population density of 14, 10, 8, 4 and 3 trees ha^{-1}, respectively. Other species such as *Acacia jacquemontti, Balanites aegyptiaca* etc. are found on the hill slopes whereas the dominant vegetation in the CARs is *P. juliflora.* The agricultural fields are dominated by *Acacia nilotica, Prosopis cineraria.* Among the shrubs *C. burhia* and *L. pyrotechnica* are the dominating species. While *Z. nummularia, Lycium barbarumm, C. polygonoides* and *Calotropis procera* are also found. The same species are also found in the CARs. The agricultural land is dominated by unwanted *Calotropis procera, C. burhia* and *A. peudotomentosa* species whereas *C. polygonoides* was found only on the boundary. Common grasses species are *D. ageptiacum, Elusine compressa, Cenchrus biflorus* and *Aristida funniculata* with a biomass production of not more than 300 to 400 kg ha^{-1}.

DEGRADED PASTURELANDS

The ever-increasing livestock population has overstocked the rangelands and has led to overgrazing. The ground cover which protects the soil against erosion has decreased and several degradation processes such as reduced soil organic carbon (0.09%) and fine clay content, diminished soil water retention capacity, low nutrient content, limited plant root depth, etc have set in. The degradation processes progressively reduce the productivity of the rangelands.

The area falls in Kutch, west of Gujarat and has a tropical monsoon type of climate. It experiences extremes of weather conditions with a cold winter and hot summer. The average precipitation is 326 mm and about 95% of the rainfall occurs during June-September. Drought is a recurring feature in the area. Six villages were surveyed and have human and cattle population of 16 and 11 km^{-2}, respectively. Livestock-rearing is the main occupation and principal source of livelihood for the people in the region. However excessive trampling and persistent grazing has modified the rangeland community structure over the years. Initially cattle overgraze palatable perennial grasses, allowing annual weeds and tougher shrubs to spread. This shift in species is the most prevalent form of range degradation. Of all woody plant invaders, *Prosopis juliflora* ranks first in terms of distribution, abundance and aggressive encroachment of rangeland/ pastures. The *Prosopis* invasion is facilitated by a curious reciprocal relationship with cattle. The late summer maturing *Prosopis* pods provide cattle with nutritious food. The invasion of *Prosopis* in the Banni area has led to a decline of indigenous grasses and other plant species. Soils of this region are classified broadly as sandy but the soils of the study area, located along the coast of Mandvi, are black soils. The soils are generally shallow and skeletal. The common vegetation of the study area comprises *Acacia senegal, A. leucophloea, A. nilotica* with a population density of 85–8 tree ha^{-1} in designated forest areas. *Z. nummularia* (35%), followed by *C. decidua* and *Comiphora wightii* are the dominant shrubs in the forest, CARs and farmers fields. The other shrub species observed in the area are *Salvadora persica, Cordia gharaf, Balanites aegyptiaca, Butea monosperma, Calotropis procera. A. nilotica* and *P. cineraria* are tree species on agricultural land. *P. juliflora* dominates in unirrigated areas while *P. cineraria* is common in irrigated land. Common herbs and grasses are *Cymbopogon jawarncusa, C. cacium, C. martinii, Cenchrus ciliaris, C. setegeirus, Tridax procumbens, Tribulus terrestris, Tribulus rajasthanensis, Dicanthium annulatum*, etc. with a total biomass production of about 1 –1.5 tonnes ha^{-1}.

The pasturelands of Jaisalmer in Rajasthan are dominated by *Lasiurus sindicus* near Mokal. The entire area is sandy, dry and highly water-deficient. Low rainfall (100-150 mm), scarce water resources, an uneven sandy surface, wind erosion and overgrazing are the major constraints. The climate is characterized by extremes of temperature and erratic rainfall. Due to the prevailing desertic condition in the area vegetation is very sparse and comprise mostly grasses and shrubs. Five villages were surveyed which have average human and cattle population density of 10 and 79 km^{-2}. Grasses appear in abundance immediately after a good shower turning the whole area into green pasture. In the dry season however it is desertic. Trees are rarely found in the area and the main species, *Prosopis cineraria* and *Salvadora persica* with population density of 1-3 tree ha^{-1} are restricted to low-lying areas only. *P. juliflora* and *A. tortilis* are also observed but are restricted to plantation sites. Among the shrubs, *Capparis decidua*, dominates in the designated forest and CARs areas whereas *Calotropis procera* dominates in farmers fields. Other species are *Leptadenia pyrotechnica, Z. nummularia*, etc. In pastureland, *Lasiurus sindicus* is the dominant fodder grass with an average clump density of 1-2 m^{-2}. Other common perennial grass species are *Panicum turgidum, Cenchrus ciliaris, P. antidotale, Cymbopogon jwaranacusa, Elusine compressa*, etc. However, grasses of low fodder value such as *Dactyloctenium sindicum, Aristida depressa* are now dominating the pastureland. On an average the production of grasses is only 295 kg per ha under open grazing conditions. When only protection is provided, the productivity is found to increase up to more than 1000 kg per ha. These grasslands have important faunal diversity also of which the great Indian Bustard is an important bird avifauna of the northwestern region of Rajasthan and needs protection conservation through the conservation of these pasturelands.

Another site is situated near Bikaner in the northwestern part of Rajasthan. The major part of the region is comprised of desolate and dreary regions. At many places there are sand dunes of varying height from 6 to 30 m. The mean annual precipitation for the last 25 years was 348 mm of which 76% occurred during the monsoon. The mean monthly maximum and minimum temperature ranged from 21-43 °C and 6-29 °C, respectively. The soil at the site is loamy sand with a very low content of soil organic matter (0.07%). The vegetation can be broadly described as tropical forest, but due to extremely low rainfall and extremes of temperature there is a great loss of moisture converting the region into a typical dry tract. However, where the moisture accumulates during the rains a few scattered stunted trees not taller than six metres high are found. The five surveyed villages had an average human and livestock population of 39 and 56 km^{-2}. Lopping and pollarding are the common phenomenon in the area carried out to feed the livestock and to obtain fuel wood. The most common species found in the region are *P. juliflora*, *A. tortilis* and *Prosopis cineraria* with population density of 37 to 7 tree ha^{-1}. Others are *Tecomella undulata* and *Salvadora oleoides*. The undulating sandy terrain is dominated by *Z. nummularia* in the plains and *Calligonum polygonoides*, *Leptadenia pyrotechnica*, *A. pseudotomentosa*, *Calotropis procera* and *Crotolaria burhia* in the uplands. *P. juliflora* dominates in the habitat area and CARs with an average population of 21 tree ha^{-1} (58%). Among the grasses, *Dactyloctinium sindicum* dominates whereas *Cymbopogon jwarankussa*. and *L. sindicus* is found in protected and agricultural areas with a grass biomass not more than 300 kg ha^{-1}. Overexploitation and selective removal of certain species e.g. *Calligonum polygonoides*, for charcoal making and use in urban areas has resulted in the complete extinction of vegetation leading to severe soil erosion. Over-herding and trampling further aggravate the problem.

SALT-AFFECTED LANDS

Salt-affected areas in Gujarat cover about 3.02 million ha (GEC, 2001) in the Greater Rann and the little Rann of Kutch in the north western region of the state. These Ranns are salt desert flats only a few inches above sea level and occupy about 23 310 km^2. They are flooded for about 4-5 months in the rainy season by a mixture of seawater driven up by the strong southwest monsoon winds and fresh water brought down by the rivers, the chief of which are Luni and Banas. However, during the rest of the year they remain a salt desert with salt few inches thick dried like snow. The problems of soil salinity are important, engaging the attention of all concerned in Kutch east near Adesar. Three villages were surveyed for primary data recording. The human and cattle population in the region is 34 and 134 km^{-2}. In the Rann areas seawater enters from nearby creeks, as they have no ridges against them and seawater floods the Rann. Further, wind blown tiny salt particles from the little Rann are deposited to adjacent agricultural fields and in due course salinity increases there also. The area has extreme of weather conditions and has three distinct seasons, winter, summer and monsoon. January is the coldest month have an average minimum temperature of 4.6 °C, however, the mercury occasionally drops below the freezing point. The maximum summer temperature ranges from 39 to 45 °C. The annual average precipitation is 326 mm with about 13 rainy days. The soil of the area is broadly classified as grey-brown and coastal alluvial soil with an SOC of 0.16%. However, skeletal soil is found in the slopes of the hilly region whereas mud soil is located in the area which comes under the influence of seawater. Salinity ingression causes land degradation and adversely affects the productivity of the area, which supports saline herbaceous vegetation i.e. *Suaeda nudiflora*, *Salvadora spp.*, *Capparis spp.*, and *Calotropis procera* and the grass *Aristida adscensoides*. *Prosopis juliflora* is the dominant species (13 -153 tree ha^{-1} in the designated forest area and 1-71 tree ha^{-1} in CARs) and has invaded these areas suppressing local flora. The other tree species found in the area are *S. persica*, *A. nilotica* (particularly on agriculture field boundaries) and *P. cineraria*. *P. juliflora* have even invaded agricultural fields with a population of 2-46 tree ha^{-1}. This region is internationally known for its faunal diversity and the famous Wild Ass Sanctuary. Among the herbs *Cressa cretica* is the common species in vegetated sites but the of Rann is totally devoid of vegetation dur to salt manufacturing in the area.

A different type of developing salinity, which needs attention, is observed in the river basins of the Saraswati, Ropan and Banas in Patan district of Gujarat. These major rivers flowing toward the Rann fringes have been dammed for irrigation in the upstream areas of Banaskantha, as a result of which fresh water which used to reduce the salinity of the area by flushing, is no longer available and therefore a considerable increase in salinity is observed in the basin area. Climatically the area is similar to the adjacent Rann fringes area. This region is highly degraded with saline ground water and few irrigation facilities. The soil is muddy flat with a very low SOC (0.16%). The vegetation river basin areas are thickly covered by *Prosopis juliflora*, an important source of fuel wood ranging in population from 129-430 tree ha^{-1}. However *P. juliflora* has invaded the CARs, affecting fodder availability for the dense livestock population (16 km^{-2}). The plants growing on the bets and edges of the mainland include *Aeloroprus lagopoides*, *Cyperus* spp., *Aristida adscensionis*, *Cressa spp. Suaeda nudiflora and S. fructicosa* .The belts support slightly mature trees of *Salvadora spp.* Check dams have increased the vegetation by increasing the moisture regime. *Suaeda fruticosa*, being a halophytic succulent is distributed on most of the belts and fringes of wide areas of Radhanpur and Jaluka. Its abundance and frequency of distribution is high compared to any indigenous plant in the area.

The dominant grass species are *Aristida adscensoides*, *Aleoropus logopoides* associated with *Cressa cretica*, *Suaeda* spp, *Cyperus* spp., *Dicanthium annulatum* which are also fairly common. *Dactyloctenium aegyptium* occurred with higher frequency with associated *Cressia cretica* where salt is leached out through runoff.

SAND DESERTIC

The region is situated 70 km from Jaisalmer in Rajasthan. The basic characteristics are an arid landscape with large sand dunes 50 to 100 metres high and 8 to 10 km in length. This is the most inhospitable region of the state; with scarcity of water the living conditions are very harsh. The region is covered with wind-blown sand giving rise to pockets of shifting sand dunes and semistabilized dunes of old origin, interspersed in alluvial soil. Extreme aridity, marked with high summer and low winter temperatures, is its usual climatic characteristics. In India, the total area affected by sand drifts is estimated at 88 078 square kilometres. Four villages were surveyed and the average human and livestock density is 12 and 159 km^{-2}. The major causes of sand drifts are over grazing and destruction of natural vegetation on dunes and sandy plains. Over-exploitation of available vegetation due to high biological pressure has resulted in sand reactivation and sand drifts engulfing villages, agricultural land, water bodies, roads and railway lines and overall misery to the area. The average annual rainfall varies from 100 to 400 mm, quite often erratic, so much so, that the entire rainfall of the year may fall on a single day and the rest of the year may be dry. Summer temperatures are always high and the diurnal range exceeds even 20° C. During the day, the summer temperatures may be as high as 49 ° C but in the night, the temperatures may fall to less than 20° C. Rainfall is very scanty and hence surface water resources do not exist while ground water resources are often deep and brackish. The soils are mainly derived through the aeolian sand with a SOC of 0.07%. The soils either associated with dunes or interdunal plains are deep, excessively drained, calcareous or non-calcareous, sandy by nature. Natural vegetation is seasonal and with the first showers in late July, a few grass species grow and shrubs/dwarf trees turn green. But, soon after the retreat of the monsoon in mid-September, the vegetation dries up, leaving only a few perennial shrubs and a thin pad of pale grass on the landscape. Trees are rare however, *Prosopis cineraria*, *P. juliflora* and *A. tortilis* are found in patches with a density of 1-2 tree ha^{-1} in designated forest, CARs and unirrigated agricultural lands. Among the shrub species, *C. ploygonoides* and *C. procera* are the dominant species followed by *Leptadenia pyrotechnica*, *Z. nummularia* and *C. decidua*. Among the grasses *Lasiurus sindicus*, *Eleusine compressa*, *Dichanthium annulatum*, *Cenchrus ciliaris* and *Cenchrus segtigerus* are the important fodder grasses, found in the flat areas of the region. However under replacement by the low fodder-valued *D. sindicum*. *T. purpurea* and *A. pseudotomentosa* are now dominant in the area.

ROCKY BARREN HUMMOCKS

The site is located in Shergarh tehsil of Jodhpur with a typically arid climate with high-level rocky structural plains and isolated hills of varying height as the dominant landform. Sandy hummocks and low sand streaks are also common features in the area. The hillocks rarely have soils whereas low-lying areas and the sandy plains have shallow soils. In sandy hummocks the SOC is 0.07% whereas in agricultural fields it ranges from 0.20 to 0.3%. Adverse climatic conditions and a sandy landscape results in frequent failure of agriculture. On the whole the climate of the region is dry. The forest as a whole is classified as dry-scrub- thorn forest. Due to rocky and sandy soils and the dry climate only shrubs and thorny bushes are found in the area. The hills are devoid of vegetation except for scattered bushes of *C. decidua*. The depressions and the plains between the hills have *A. senegal* and *P. cineraria* as the tree species with a tree density of 1-2 tree ha^{-1}. The hummocks have vegetation such as *C. decidua, Z. nummularia and L. pyrotechnica*. In farmers fields, *P. cineraria* and *A. senegal* are the common species with scattered *T. undulata*. *A. tortilis* is the species used in stabilization of sand dunes. *Prosopis juliflora* dominates in the CARs. Among the shrubs *C. procera* is the dominant species while *Z. nummularia, L. pyrotechnica* and *C. decidua* are found throughout the site. Among the herbs and grasses *T. purpurea* is the dominant species followed by *C. burhia, A. pseudotomentosa* and *A. mexicana*. In agricultural fields *C. burhia* and *A. pseudotomentosa* are the dominant species. *Cenchrus ciliaris*, *Cenchrus biflorus* etc. are the species, however the productivity is very less due to uncontrolled grazing and over-grazing.

ANNEX E: SOCIO-ECONOMIC CONTEXT OF THE PROJECT AREAS

SOCIO-ECONOMIC PROFILE

The arid and semi-arid areas are characterized by a society steeped in religion along with class/caste hierarchies, absence of adequate means of livelihood, absence of women's organizations and accompanied by a rudimentary infrastructure - poor communication networks, inadequate developmental institutions/agencies, lack of educational/vocational facilities and inadequate outreach for transfer of relevant technology. The result, quite obviously, is that there remains a largely untapped and underdeveloped industrial potential even in the agricultural sector that is the mainstay of communities inhabiting arid and semi-arid areas.

Table H.1. Socio-economic profile of India - Rajasthan and Gujarat

Item	India		Rajasthan		Gujarat	
	1951	2001	1951	2001	1951	2001
Population (in millions)	361	1027	15.9	56.47	16.3	50.6
Percentage of urban pop		25.71	18.50	22.8		34.4
Population density	117	324	46	165	83	258
Average size of landholding (01) (per ha)	1.57		4.11		2.93	
Per capita food grain production	196 kg		196.81 kg		100.9 kg	
Per capita income (01)	16047		12914		18625	
Livestock (1997)	470.83		54.7		19.67 (1992)	
C/R Ratio	0.35		0.57		0.32	
Literacy rate	65.38		61.03		69.97	

In this region, as a whole, the land use pattern has been purely agricultural. It has, however, changed over a period of time to animal husbandry. The physiographic location of Rajasthan and Gujarat in Thar Desert enables to have both cropping seasons - kharif and rabi depending upon the rainfall.

POPULATION

India with its population is 1027 million mainly an agrarian society. Its economy is based on agriculture. The population growth from a mere 361 million in 1951 to 1027 million in 2001 is a phenomenal increase and gives an average land holding of 1.57 ha only (Table H.1). The decadal growth rate of population is 21.34 % for India and 28.33 and 22.48 per cent for Rajasthan and Gujarat, respectively. The percentage of urban population is 25.7 in India. In Rajasthan and Gujarat it is 22.8 and 34.4% respectively. The pressure of population in the Indian desert is much higher than in any other tropical desert in the world.

The urban population in Rajasthan has multiplied more than six times from 1.6 million in 1901 to more than 10 million in 1991 (GoR, 2001). In the first half of the century, the net increase in urban population was only 1-4 million but during the last 30 to 40 years, this addition has been about 4 million which is three times the number added to the urban population in the first half of the country.

LIVESTOCK POPULATION

India has a total livestock population of 470.83 million comprising cattle, buffaloes, sheep, goats, camels and pigs. Cows and buffaloes are the common milch animals reared throughout the country. However, there is a large population of unproductive livestock also. Livestock-rearing is an important occupation of farmers in the arid and semi-arid regions to augment farm income. Rajasthan and Gujarat are states rich in animal wealth. Rajasthan has the distinction of having the largest population of cattle, sheep and camels of different breeds. The camel is a draught animal used for transport of goods and human beings. However, the camel population has decreased by 8.5 % from the recorded in the 1992 census. There has been increase in the buffalo population by 26% in Rajasthan. Gujarat has total livestock population of 19.67 million. Cattle, buffaloes, sheep and goats are the major livestock.

LITERACY

Eradication of illiteracy is one of the country's major challenges. Literacy is essential and desirable for improving economic, cultural and social standards in our country. In Rajasthan the literacy rate has risen remarkably in the last thirty years from 18.12 % in 1961 to 61.03 in 2001. However, it is still below the country average of 65.33 % (Table H.1). In Gujarat literacy is higher than the country average.

ECONOMY

India's economy encompasses traditional village farming, modern agriculture, handicrafts, a wide range of modern industries, and a multitude of support services. More than a third of the population is too poor to be able to afford an adequate diet. India's international payments position remained strong in 2000 with adequate foreign exchange reserves, moderately depreciating nominal exchange rates, and booming exports of software services. Growth in manufacturing output slowed and electricity shortages continue in many regions. Per capita income is much lower in Rajasthan. However, per capita land holding is higher in comparison to the country average and per capita food grain production is on a par.

DEGRADED FORESTLAND

Banaskantha and Sabarkantha districts in northeastern region of Gujarat and Bugav (Jalore district) in Rajasthan have been selected for the project. The human population density in Banaskantha and Sabarkantha region is 270 km^{-2} and the cattle population density is 207 km^{-2}. The local population largely depend on the forest area for their day-to-day living. The villages have a primary health centre, public distribution system, post office and primary school and have good approach roads. For a majority of people (89%), agriculture is the main occupation and source of livelihood. Land holdings are generally very small with an average holding of 3.4 acres per household. Cultivation is practiced even on hill slopes, without any soil conservation measures using very primitive methods. Bheel, Thakur, Pathan Begaria, Gamar, Taral, Rajput, Rabaris, Garshias, Tribhandas and Thakardas are the main castes in the area. Economically and culturally, the people are dependent on forests. If the forest area happens to be close to the village, the people depend on it totally for grazing cattle. Tribals and other forest inhabitants of the villages depend upon forests to some extent for their small timber and firewood needs. Besides agriculture, animal husbandry and manual labour are important occupations. The average income from agriculture is Rs 3607 per annum after fulfilling household requirements. Animal husbandry and labour generate an average income of Rs 2286 per month. The population also depends on various activities of the Forest Department. During early monsoon and in the early part of winter, the villagers remain busy with agricultural operations. Those who do not possess land holdings either encroach upon new forest areas to cultivate, or work as agriculture labourers for large landholders or are engaged in forest plantation works. In the remaining part of the year they supplement their income by collecting and selling forest produce such as grass, timru leaves, mahua flowers and fruits, honey, salai gum, safed musli, etc. Very often the extraction is beyond sustainable limits. The total irrigated area is 20% of the cultivated area. The kharif millet crops include pearl millet, maize, pigeon pea, green gram, moth bean, black gram, cow pea, cluster. Kharif oil seed crops include: ground nut, seasamum and castor; cash crops include: cotton, fennel, vegetables. Cereals include: wheat, barley, gram whereas rapeseed and mustard are common oil crops. The production of some major crops is 370 kg ha^{-1} for wheat, 400 kg ha^{-1} for maize, 250 kg ha $^{-1}$ for arhar and 100 kg ha^{-1} for castor. Condiments spices and drugs and cultivated include cumin, methi, isabgol, fennel, rabi, tobacco, potato.

The average fuel wood consumption is found to be 11.3 kg per family per day, which is collected mainly by the female members of the family from the forest and nearby field. In winter the consumption is a little higher (13.2 kg per day). Dung cakes are also used at the rate of 2 kg per day per family. Besides this crop residues are used in small amounts. Kerosene is another form of fuel used by very few families with an average consumption of 168 litre per annum.

The site selected in Jalore district of Rajasthan is covered with deposited sand with hilly outcrops. The total area is 10 640 sq km with human population density of 76 per km^{-2}. The villages have a primary health centre, public distribution system, post office, primary school, and have good approach roads. The literacy rate is 46.51%. The main occupation of the region is agriculture and animal husbandry with an average land holding of 6.57 acres per family. Nearly 70 % households are dependent on agriculture and animal husbandry, others are engaged as labourers in a nearby factory. The density of livestock population is 42 km^{-2} (Table H.2). *Penisetum typhoides*, *Sesamum indicum* and kharif pulses are the main crops of the rainy season. Wheat, barley, mustard and gram are grown as irrigated crops or on conserved soil moisture during rabi. Irrigation is available in 6.9 % of the cultivated area only. The average annual income from agriculture is Rs 3481 and income from animal husbandry and labour is Rs 746 per month. The groundwater level is high in the river basins, and is generally tapped for irrigation. However, the high population of livestock leads to overgrazing and a collapse of the villager common's productivity of the village commons and the forest area as observed through scrub formation of *A. pendula*, indicator of heavy grazing pressure.

The average fuel wood consumption in this area is 7.4 kg per family per day, which is collected mainly by the female members of the family from nearby agricultural fields and village commons. Dung cake is also put in use at a rate of 2.5 kg per day per family. Besides this crop residues are also in use in small amount. Fuel consumption is slightly high in winter months.

Table H.2. Human and cattle population at different locations at the site

S No	Site	No of villages	Total area (in ha)	Human population Total	Human population Density (km^{-2})	Cattle population Total	Cattle population Density (km^{-2})
Gujarat							
1.	Banashkantha	14	7172.62	10 431	270	8 559	207
	Sabarkantha	10		8 899		6 250	
2.	Radhanpur	5	25558.09	5 332	21	4 037	16
3	Kutch east	3	10139.94	3 453	34	13 486	134
4.	Surendra nagar	7	5561.45	3 481	63	3 100	56
5.	Kutch west	6	30788.55	4 911	16	3 330	11
	Sub total		79220.65	36 507	46	38 762	49
Rajasthan							
6.	Jalore (Bugao)	2	1981.52	1 510	76	830	42
7.	Barmer (Kundal)	5	12801.00	4 635	36	3 708	29
8.	Jodhpur (Shergarh)	7	20378.00	14 279	70	8 640	42
9.	Jaisalmer (Mokal)	5	43588.00	4 443	10	34 365	79
10.	Jaisalmer (Ramgarh)	4	30238.00	3 615	12	48 030	159
11.	Bikaner (Johrbeed)	5	14915.00	5 750	39	8 396	56
	Sub total		123901.52	34 232	28	1 03 969	84
G. Total		72	203122.17	70 739	35	1 42 731	70

LAND WITH SCRUB

Seven villages in Saurashtra region were surveyed. These villages are situated in Chotila taluka of Surendranagar and Wankaner taluka of adjoining Rajkot district. The area forms a plateau surrounded by a chain of hillocks with a maximum elevation of 357.53 m. The tract lies close to the Tropic of Cancer and has a deficient water supply. The industrial sector is the major consumer user of water resources along with the agriculture and domestic sectors. Rivers, rivulets and seasonal streams are the main sources of water. Water is also supplied by minor dams/irrigation projects. Most villages have huge portions of wastelands and Gauchar lands, which are in an extreme state of degradation. The forests of this region are classified as mixed dry deciduous and thorny forests. The composition of vegetation in this area is dominated by *A. senegal, A. leucophloea* and *P. juliflora,* in different proportions. There is potential for tapping gum from *Acacia senegal.* Guggal (*C. wightii)* is another commercially important species found in the hilly areas but in low abundance. *Prosopis juliflora* is the main source of fuel wood for the local people.

The villages have a primary health centre, public distribution system, post office and primary school and have good approach roads. The total human and cattle population of the region is 3481 and 3100 and the population density is 63 km^{-2} and 56 km^{-2}, respectively. The literacy rate is very poor in the area with only 29 % literate. The houses are all electrified and most of them are pucca and semi pucca. The main source of livelihood in the area has been agriculture and animal husbandry (52%) followed by factory employment (24%) and unskilled labour (20%). Some villages are have dairy collection centres. The region is rich in minerals such as coal, fire clay, limestone and silica sand. Ceramic industries are in abundance in and around Chotila, which provide employment to the local people. The average annual income from agriculture is Rs 7 582 and from other sources Rs 1 683 per month per family. The average size of a land holding in the area is 7.14 acres of which 28% is irrigated. Individually owned bore wells are the main source of irrigation. Some people water from canals also. The water table in the villages situated near dams is increasing. At places it is within only 2-3 feet from the ground. Farmers use this water for irrigation through dug wells. The main crops are cotton, mustard, jowar, bajra, mung, castor and wheat. Fuel wood consumption is found to be little higher than other surveyed area, on an average 15.7 kg per family per day. Cow dung is another source of fuel used by the local people with consumption of 3.2 kg per day per family. Some people use kerosene also.

GULLY/ RAVINES

The western slopes of the Aravalli hills in and around Siwana and Kundal range in Barmer district, face problems of sandy ravine formation, the main form of degradation in the region. Ground water recharging has almost stopped because of runoff problem and demands immediate attention for increasing productivity in this region. Sand movement and deposition is also posing threat to nearby agricultural fields. Agriculture and livestock rearing are the main occupations of the people. The total number of humans and livestock of the region is 4635 and 3708 with a population density of 36 km^{-2} and 29 km^{-2} respectively.

The villages are electrified and 50% of households enjoy this facility. The villages are supplied good drinking water through civil administration. The villages have a primary health center, public distribution system, post office and primary school and have good approach roads. Houses are mostly kuchcha. Literacy among the females is very low (9 %) with 34 % overall literacy. Agriculture is the main source of livelihood and 88% of the total population is involved in it with an average land holding of 16 acres. The rest are graziers, skilled and unskilled labourers. Jeera, bajra, jowar with short duration summer pulses are the major agricultural crops in the region. However, wherever irrigation is available (37.2 % of cultivated area) farmers also grow wheat and castor. The source of irrigation is mainly open wells and tube wells. On an average 14 kg fuel wood is consumed per day per family, collected mainly by the females from nearby village commons.

SALT-AFFECTED LAND

The sites selected include Adesar in Rapar taluka of Kutch east, which has a of human population density of 34 km^{-2} and cattle population of 134 km^{-2} (Table H.2). All villages are electrified. The villages have a primary health center, public distribution system, post office and primary school and have good approach roads. Almost all the people are illiterate with only 16% literacy consisting of mainly school-going children. The source of drinking water is a public well, perennial in nature and within a distance of 1-1.5 km. However, there is a scarcity of good quality potable water in the summer months. A harsh site with a combination or salinity and erratic rainfall, the occupation of the people is agriculture and animal husbandry. People generally prefer cash crops such as cotton. The main crops grown in the region are cotton, bajra, jowar and gram. Among oil seeds, rapeseed and mustard are common. Nearly 73% of the people are involved in agriculture and animal husbandry. The rest of the population is dependent on unskilled labour for their livelihood. It is important to note that about 32% households are landless. The majority of households have <2.5 acres of land with only 10% having >10 acres. Some people depend on land tenancy from landowners. Only 3% cultivated land is under irrigation available from a nearby check dam. The average annual income from agriculture is Rs 6 619 per annum per family and from other sources Rs 1 461 per month per family. Dominant castes are Muslim (30%) followed by Barwad 25%, Yadav, Koli, Godvi and Brahmins. The average fuel wood consumption is 18 kg per day per family while; cow dung is consumed at the rate of 4.2 kg per day per family with a small amount of crop residue also being used. Fuel wood is collected daily, usually by females from nearby agricultural fields and village commons, *Prosopis juliflora* being the single most important species exploited for fuel wood.

A different type of salinity development process, which needs attention, is observed in the river basin in Patan district of Gujarat where five villages were surveyed. Pucca roads connect the villages and all have a primary health centre, PDS, post office and primary schools. The villages are all electrified but most of the houses are kuchcha. Drinking water facility is being provided via the Netherlands pipeline project. The human and cattle population densities are 21 km^{-2} and 16 km^{-2}, respectively. The literacy rate is 27 %. Main castes are Thakur, Patel, Barvad and Harijans. This region is highly degraded with saline ground water and few facility for irrigation with average land holding of 12.79 acres. Soil is muddy, flat with a very low SOC (0.16%). The main occupation in the area is agriculture and animal husbandry. Jowar, bajra, cotton and gwar are the main crops. Agriculture generates an average income of Rs 3000 per family per year after fulfilling the household requirements. Other sources also generate an income of Rs 2600 per month per family. The vegetated river basin areas are thickly covered by *Prosopis juliflora*, an important source of fuel wood ranging in density from 129-430 trees ha^{-1}. Average fuel wood consumption is 17.4 kg per day per family. Only a few families use cow dung. Besides this kerosene is also used. Fuel wood is collected by female members of the family.

DEGRADED PASTURELANDS

The areas were selected to address the problem of fodder requirement and livestock management and the selected site is located in Abdasa and Nakhatrana talukas of Kutch district. A survey was conducted in 6 villages. 42% literacy was recorded in the surveyed area. The villages have a primary health centre, public distribution system, post office and primary school and have good approach roads. Agriculture along with livestock-rearing are the main sources of livelihood for the people of this region. However, a large number of households depend on daily labour for their livelihood. This may be because of the degraded state of pastureland, which is forcing people to switch over to other sources of income. Soils of this region are classified broadly as sandy but the soils of the study area, located along the coast of Mandvi, are black soils. The soils are generally shallow and skeletal. The area has a human population density of 16 and cattle population of 11 km^{-2} (Table H.2). The average income from agriculture is Rs 13106 per annum (after fulfilling the family requirement) where nearly 50% population is dependent on agriculture. Approximately 30 % agricultural land is irrigated. The income from other sources is Rs 2 500 per month per family. People prefer growing salinity-tolerant crops viz., groundnut and cotton. Groundnut is cultivated mainly in Nakhatrana and Mandvi. Cotton is highly salinity-tolerant and is cultivated in Mandvi, Anjar and Bhachau talukas. There is a significant decrease in the area under cotton cultivation probably because of salinity development. The people generally depend upon the village commons and nearby forests for their fuel wood requirement. The average fuel wood consumption is 8.65 kg per day for a family and, on an average 1.5 kg dung cake is also used as fuel wood along with crop residue. LPG and kerosene are also used for cooking.
In the vicinity of Jaisalmer, five villages namely Lila Parewar, Parewar, Badhasar, Mokal and Sonu, which are mostly on sandy plains were selected for the project. The villages are sparsely distributed and most of the population (more than 90 %) is engaged in cattle-rearing and sometimes in rain-fed agriculture. The total human and cattle population of the region is 4 443 and 34 365 with a population density of 10 and 79 km^{-2}, respectively (Table H.2). The

villages have a primary health center, public distribution system, post office and primary school and have good approach roads. The literacy rate is found to be low, 32% only. The villages are provided with electricity but only 22 % households use it. Almost all the houses are Kuchcha. Drinking water is available within a range of 1 km from a public tube well and hand pumps, which are perennial. Children are mostly engaged in cattle-rearing. The average household income is Rs 4 913 from animal husbandry and from other sources, income is Rs 2 765 per month per family. Trees are rarely found in the area and *Prosopis cineraria*being the dominant species. Among the shrubs, *Z. nummularia*, *Capparis decidua*, *Calotropis procera* and *Leptadenia pyrotechnica* etc. are common species. *Lasiurus sindicus* is the dominant fodder grass in the pastureland with an average clump density of less than 2 per square metre. However, non-palatable grasses like *Aristida* spp. are invading the grasslands. Rajput and Meghwal are the dominant castes followed by Dholi, Miras, Nai, Bheel, Darjee and Jogi. Wood and cow dung are main sources of fuel for cooking the consumption per family is nearly 3.6 kg and 4 kg, respectively, in summer and during the winter the consumption is 4.7 and 5.15 kg, respectively. Fuel woods are collected from the nearby village commons.

Another site is situated near Bikaner in the northwestern part of the Indian desert. The major part of the region is composed of desolate and dreary regions, which form part of the Great Indian Desert of Thar. At many places sand dunes may vary in height from 6 to 30 m. Five villages were surveyed in this area. The human and livestock population density is found to be 39 km^{-2} and 56 km^{-2} respectively (Table H.2). Rajput and Meghwal are the main castes. All the villages have good approach roads, have electricity supply and 50% of the houses are electrified. The villages have a primary health center, public distribution system, post office and primary school. The literacy rate was found to be 40%. Civil administration supplies drinking water to these villages. Agriculture and animal husbandry are the main sources of livelihood in the area with an average landholding of 11.49 acres. Agriculture is largely rain-fed with only 7.5% of the area irrigated – tube wells are used for irrigation. Source of irrigation are tube well. The farmers earn an average annual income of Rs 9 958 from agriculture and an additional income of Rs 2336 from other sources. Lopping and pollarding are common practices in the area to feed the livestock and to obtain fuel wood for cooking. Overexploitation of *Calligonum polygonoides* from the sandy tract for its valuable fuelwood has put this species near extinction. People are also removing this species from their fields to cultivate groundnuts on the land using ground water, which is generally saline. On an average 8-10 kg fuel wood is consumed per family per day along with a small amount of cow dung, which is mostly collected by female members of the family.

SAND DESERTIC

In Ramgarh (Jaisalmer district) four villages namely Boj Raj ki dhani, Ranau, Ghantayali and Tanot were selected. All these villages are connected by the Ramgarh-Tanot road. The total number of households and total population of all the selected villages is 325 and 3 615, respectively. The total human and cattle population of Ramgarh is 3 615 and 48 030 with a population density of 12 km^{-2} and 159 km^{-2}, respectively. The literacy rate is 30% and only 11% of the households in one village were electrified. All other villages did not have access to electricity. The only drinking water facility available in the area is a perennial public well. The dominant caste is Rajput except Tanot village where all the people belong to the Meghwal community (SC). The main occupation of the villagers is animal husbandry followed by casual labour if work is available. Agriculture is only rain fed wherever it is practiced. The main feature of these villages is that one murba, i.e. 3-4 ha land, is distributed for agricultural purposes to the villagers in the canal command area. far from the villages. The average annual income from animal husbandry is Rs15 428 and from other sources Rs 6 242 per month per family. People are dependent on forests for fuel wood. Dung cake is also used as cooking fuel; consumption of fuel wood and dung cake is 3.4 kg per day and 3 kg per day in summer and 4.4 kg per day and 6.1 kg per day per family in the winters, respectively.

ROCKY/ SANDY HUMMOCKS

The site is categorized as hummocks with rocky outcrops but sand dunes are also common formations. It is located in Shergarh tehsil of Jodhpur having a typically arid climate. The area is mostly covered by wind-blown sand interspersed with rocky outcrops of varying height. Adverse climatic conditions and the sandy landscape results in frequent failure of agriculture. Agriculture and animal husbandry are the main occupations. The total livestock population is 8 640 and the human population is14 279 with a population density of 42 km^{-2} and 70 km^{-2}, respectively. All the villages are electrified. The villages have a primary health center, public distribution system, post office and primary school and have good approach roads. The sources of drinking water are open wells, ponds, hand pumps and pipelines all available within a range of 2 km. However, the quality of water is poor and it is scarce during the summer months. The dominant caste is Rajput followed by Meghwal, Dholi, Suthar and Bheel.

Agriculture is mainly rainfed with only 1% of the irrigated. Major crops are bajra, gwar, moth, mung, til and wheat. The average annual income from agriculture is Rs 4 085 and from other sources (mainly from government jobs) is Rs 6 000 per month per family. There is a rich tradition in the area of joining the armed forces.

The consumption of fuel wood is 8.5 kg per day per family on an average along with 2.5 kg cow dung. Women and children collect these from the nearby village commons.

ANNEX F: THREATS AND ROOT CAUSES

The problems facing integrated ecosystem management through conservation of globally significant biodiversity and increasing carbon sequestration in arid and semi-arid regions of north western India originate from five related issues: 1) Deforestation and removal of natural vegetation for cropping or cattle rearing, road construction, urban development etc, 2) Overgrazing (destroys soil cover, causes compaction and fosters the encroachment of undesirable shrub species), 3) Improper land management including cultivation of fragile soils, reduced fallow, 4) Diversion of rivers for irrigation purposes or irrigation of inadequate soils, 5) Overexploitation of vegetation for fuel, fodder, fencing etc., where the remaining vegetation no longer provides sufficient protection from soil erosion. Increase in mine spoils, diversion of population to the urban areas and industrial activities are the other sets of problems originating in the region intensifying the pollution problem.

The project development process conducted a major participatory planning exercise with representatives of various stockholders i.e. farmers, pastoralists, village community, women, NGOs, SHG's, agriculture, livestock and forestry extension services and all baseline projects as well as villages leaders as rural advisors. This process identified seven priority areas to restore and conserve globally significant biodiversity and increase carbon sequestration. The threats observed in these seven priority areas covering eleven sites are: land conversion for purposes other than forestry or grazing, overgrazing of CARs and pasture lands, deforestation, over-exploitation and selective extraction of natural resources and non-timber products. Annex I provides threats and root cause analyses and the matrix for threats, root causes and alternative strategies.

INTENSIFICATION OF THE AGRICULTURAL PRODUCTION SYSTEM

Conversion of forest, pastureland into crops lands/or encroachment to the CARs for agricultural production is pushing pastoral activities more and more into the forest area – even in reserve forest and parks. The main problem is the gradual extension of cultivation to hill slopes or fragile sandy terrain, which was previously left aside because of the fragility of soils or of other limiting factors. This is a common phenomenon in situations of land hunger, i.e. where a high population density competes with arable land. Population growth requires the extension of interference into new areas of lower resilience and higher sensitivity for which existing management practices may be inadequate leading to land degradation unless particular measures are taken to protect soil structure and maintain fertility.

A different set of improper practices has to do with faulty intensification: shortening fallow, insufficient fertilization, excessive fertilization, or the various forms of inadequate management of irrigated areas. The elementary way to extract more produce from land which is not cultivated permanently, is to shorten the fallow period to which it is subjected. However, in the absence of other technological changes, this led the growing poor rural populations to increasingly degrade and mine the natural resources to ensure their day-to-day survival. Further, under permanent cropping, the need for increased produce leads to irrigation and fertilization, as well as to higher cropping intensities, which resulted in land degradation problems such as salinization and water-logging of irrigated areas, and pollution by pesticides or fertilizers.

A factor with a significant bearing on soil properties related to productivity is soil organic matter (SOM). The clearing of forestland, intensive cropping and imbalanced fertilizer application leads to depletion of SOM content. The organic carbon content declined significantly due to intensive farming, which is possibly due to the enhanced oxidation of the soil organic matter. Since the SOM status was found to increase from as low as 0.25% to 0.85% after long-term soil fertility management, it is obvious that the present levels are much below the climate-driven equilibrium in arid and semi-arid areas. The beneficial effect in improving organic carbon status of the soil was observed at several locations and needs to be given on priority as maintenance of SOM is of paramount importance in controlling land degradation in rainfed areas. It should be maintained at least at the current level through greater biomass input, optimum tillage and other soil management practices

OVERGRAZING

Excessive pressure on forest, pasturelands and common access resources (CARs) by livestock can be a crucial problem of dry areas where rangelands and CARs are much more crowded. While livestock does not necessarily cause environmental problems, overgrazing can be a major factor in deforestation and land degradation. The growth of livestock population leads to the extension of grazing activity into forests and semi-arid marginal lands ultimately causing land degradation. Even where grazing is allowed (e.g. CARs and pasturelands), lack of effective regulations for natural management lead to overgrazing, conflicts between " residents" and non-residents transhumants and conflicts between farmers/ foresters and pastorlists. Selective and overgrazing favours the encroachment of undesirable species likes *P. juliflora* in CARs and pastureland leading to a different set of problems. High pressure of livestock on grazing lands, particularly in view of their low carrying capacity, results into over use of these lands and depletion of the natural vegetation resources. For example *Sehima nervosum* recorded an optimum plant cover of 11.5% but reduced to 0.1 to 0.2% due to the impact of grazing. Similarly high basal cover of *Cenchrus ciliaris* and *C. setigerous* on the sandy loam soil of Sojat reduced to mere 0.5% from 19.8%. On the sandy loam soil at Hajri (Jalore district) the initial basal cover (24.0%) of *Dichanthium annulatum* reduced to only 5% due to unrestricted grazing. In absence of readily available intensification and diversified income generation techniques, particularly for small ruminants that are appropriate to the socio economic and ecological situation, these factors exacerbate by the attitude to mistrust between pastrolists and protected area managers.

DEFORESTATION

The removal of vegetation cover starts or accelerates soil losses either through wind or rainwater. The other cause of destruction of the vegetation cover is its overuse by households, mainly for fuel wood collection. To cover vital energy needs, most households in the area resort to free gathered biomass fuels, including crop residues and animal dung but most of all, fuel wood. Annual use of wood always exceeds the sustainable yield of forest or wooded areas, forests and woodlands are gradually destroyed. This in turn triggers or accelerates soil erosion and loss of productivity in the region. The impact of population growth on fuel wood consumption in the vast areas concerned is direct, since energy needs are essentially proportional to population. Added to this, population dynamics plays an important role in urbanization. A first effect arises from population concentration, which makes the impact on resources felt acutely over a peripheral zone, which typically suffers disproportionately from deforestation. A second effect arises from changes in habits: urban dwellers frequently prefer charcoal to wood; this increases the impact on wood resources per consumption unit.

DRY LAND SALTING

Soils suffering from salinity alkalinity are widespread and are emerging as an important problem in the area. At presently 1.04 million ha is suffers from salinity and alkalinity with an additional 1.86 million hectare which covers the Ranns of Gujarat basically marshy tracts. Utilization of ground water in a highly sensitive desert area is hazardous and should only be undertaken after adopting artificial recharge methods along with monitoring static water levels and the salinity level. In arid Rajasthan, irrigation with saline soil water and over-irrigation in drained soils having a salt rich hard pan at medium to shallow depth, has accelerated the salinity-alkalinity build-up in many parts of the medium-to-heavy textured alluvial plains. In the Indira Gandhi Canal Command area water logging and salinity-alkalinity are increasing fast pace. The water logging has increased 2.6 times during the past decade. Excess irrigation in locations having a gypsum-rich soil layer at shallow depths and inadequate drainage is the major causes for land degradation in this area.

In Rann areas the seawater enters from nearby creeks, as they have no ridges against and floods the Rann. Salinity ingression from the sea sources causes land degradation in this area and salinity–alkalinity buildup limits the productivity of vast areas of agricultural land. Further, windblown, tiny particles of salt from the little Rann of Kutchch are deposited to adjacent agricultural fields and in due course of time salinity increases in that area also. These processes adversely affect the productivity of the Rann fringe area. Lack of sheltering and vegetation forces the people to a nomadic way of life. Damming of rivers such as the Saraswati, Ropan and Banas results in development of salinity as the fresh water, which used to reduce the salinity of the area through flushing, is no longer available in river basin area of Patan district of Gujarat. In the coastal plains excessive pumping of potable water along the seaward margin of the plains is now leading to intrusion of seawater into the fresh water aquifers. Since the farmers have no other choice, they continue to use the sea-replenished ground water for irrigation despite its poor quality. Lack of incentive, proper resource management techniques and the high cost of saline land vegetation are the major constraints in the area.

OVER-EXPLOITATION AND REMOVAL OF VEGETATION

Over-exploitation of *Calligonum polygonoides* from the dune area for fuel, *Dendrocalamus strictus* and Safed musli for multipurpose uses and medicinal value from forest areas are the present examples of threats in the areas. Due to the decrease in economic returns from crop cultivation, there has been an increase in harvesting of these products from the protected areas. Evidence suggests that the rate is strong enough to affect regeneration of the plants, as well as feed sources of wild animals. Lack of incentives from co-management result in opportunistic action by local communities.

Destruction of natural plant cover in the sandy terrain, for fuel and fodder and extending the areas of cultivation to less suitable sandy tracts and higher slopes of sand dunes are the main causes of wind erosion with an average 50-100 kg ha^{-1} of sand removal every year from the dune-covered tract of the desert. Large-scale introduction of tractor ploughing in the sandy terrain, including the dune slopes, is increasing the sand load manifold for aeolian processes and is threatening more areas through new dune formation and the advancement of old dunes. Increased cultivation of the marginal lands with high slopes and shallow soils, destruction of natural vegetation for fuel and fodder, overgrazing and other destructive uses accelerates the process of run-off induced erosion also. Sheet and rill/gully development occurs with increased rainfall of 350 mm to 500 mm. The major reasons are: in the Aravalli hill ranges, the hill slopes are regularly deposited with wind blown sand and denuded of natural vegetation cover for fuel and fodder. Consequently, washing out of the soils resulted in sheet, rill and gully erosion. Sometimes, there is hardly any soil left to start a replantation programme.

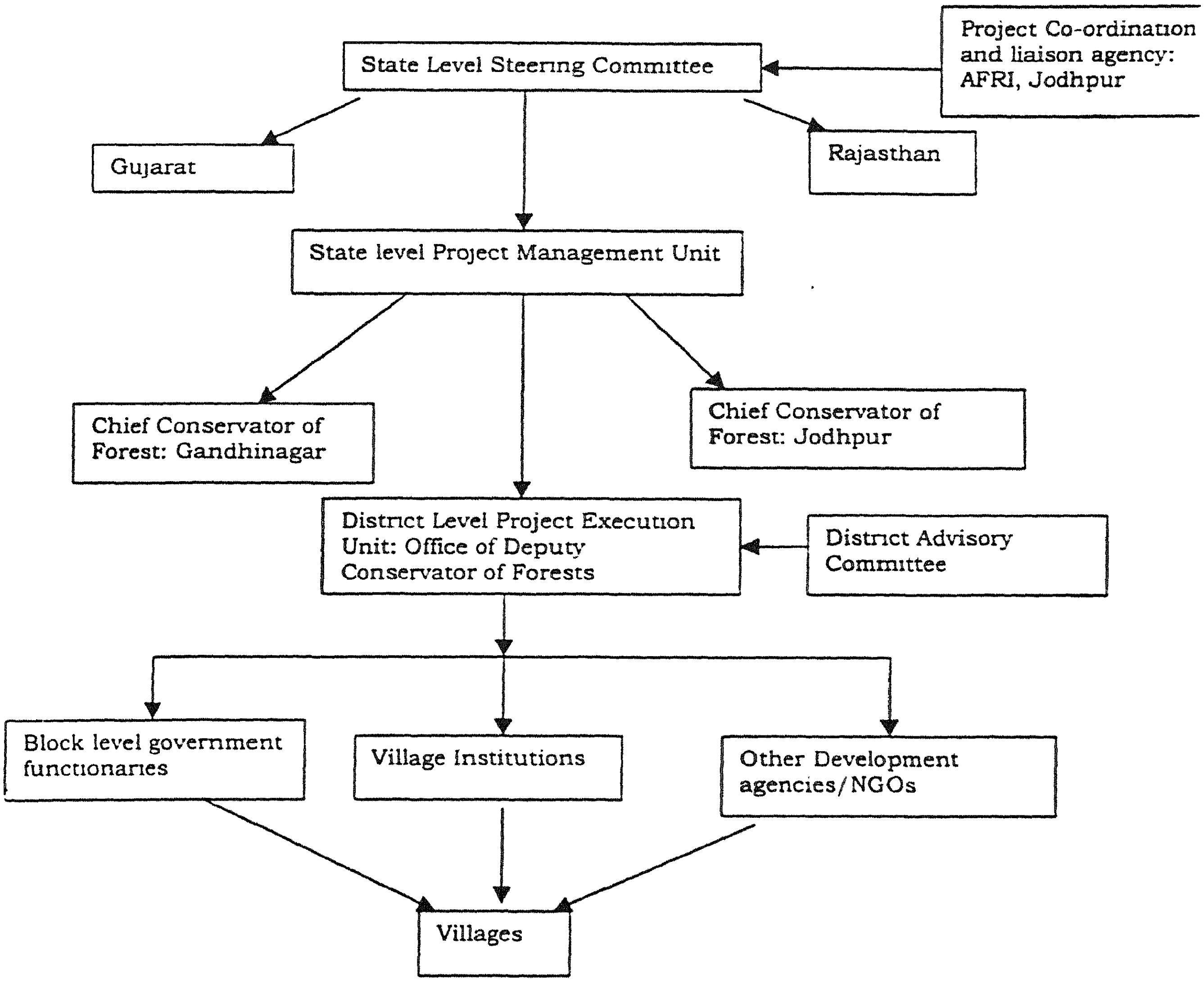
INCREASE IN MINE SPOILS

Mining is fast becoming a major factor for deforestation and land degradation in some areas of the arid and semi-arid regions especially due to unplanned open-cast mining and dumping of mines spoils in the vicinity of agricultural land. Despite the new environmental regulations, small entrepreneurs who can hardly take up any posit mining management of the mined pits and waste dumps largely practice open cast mining of sand stone, limestone, marble, gypsum and clay. Consequently, the areas gradually turn into wastelands. The mined materials such as limestone, china clay, fuller's earth, badarpur, calcite and gypsum generate fine particles, which are washed down the slopes with runoff and get deposited in the adjoining cultivated fields as a less pervious layer. Ultimately it leads to water-logging and salinity building-up.

POPULATION MIGRATION AND INCREASED INDUSTRIALIZATION

In any calamity there is a diversion of most of the population to the nearest city or town causing a significant increase in the population of urban areas. Simultaneously the requirements for the day-to-day resources increase leading to an increase in industrial growth and water use. Ultimately it produces wastewater from industrial, municipal activities and the occasionally storm water during rain, which if not properly disposed accelerates the process of environmental degradation. In the arid region of Rajasthan, mismanagement of effluents from the textile print and dyeing industry and their discharges into ephemeral streams such as Jojri river at Jodhpur, the Bandi at Pali and the Luni at Balotara, has contaminated surface and ground water downstream of the effluent discharge sites. Irrigation with such wastewater without proper management has degraded the quality of land and affected crop productivity.

ANNEXURE G: IMPLEMENTATION ARRANGEMENT


State Level Steering Committee
Project Co-ordination and liaison agency: AFRI, Jodhpur
Gujarat
Rajasthan
State level Project Management Unit
Chief Conservator of Forest: Gandhinagar
Chief Conservator of Forest: Jodhpur
District Level Project Execution Unit: Office of Deputy Conservator of Forests
District Advisory Committee
Block level government functionaries
Village Institutions
Other Development agencies/NGOs
Villages

ANNEX H: TECHNICAL STRATEGY FOR GEF ALTERNATIVE

The activities to be conducted within the GEF alternative at the legal policy and institutional levels in the forest area, common access resources (CARs) and farmers land are aimed at applying sustainable solutions to the desertification and land degradation problems that were identified. The proposed activities would help to remove the obstacles to sustainable development, which are not addressed in the baseline and ensure the sustainability of the measures implemented and their success into the post project phase. The technical specifications and strategies are based on a review of lessons learnt in the region and elsewhere. Stakeholders in the project development process suggested many interventions provided below. Many of the techniques below have been tested in the institute or elsewhere. However, they have often not been replicated spontaneously. This is either because the technology still needs improvement or there are policy, technological, financial or other barriers to their widespread adoption. In the case of the former, the project will endeavor to show innovative improvements and in the case of the latter, this project will assist in lifting these barriers.

LEGAL, POLICY AND INSTITUTIONAL ISSUES

Promoting activities for conservation and improvement in forest areas joint management will require to improve in the present legal status and adapting it to allow effective people participation. In addition, once present obstacles to participation have been removed, the legal provisions will need to be revised in order to guarantee access to and equitable sharing in the profits achieved in the areas. In this regard, the criteria for development, which is the basis for land attribution will also need to include livestock farming, whether individual or collective as confirmed by one or several of the local management committees. Furthermore it will be necessary to legalize the common property resources by means of a real transfer of responsibility and by instituting them by a decision of the village communities concerned.

Development policies will have to be made equitable for all categories of actors and stakeholders in the area of natural resources management. This is crucial to the success of the cooperation and concentration mechanisms. In addition, a review of the current development policies in the agricultural, pastoral and forestry sectors will be conducted in order to identify and remove the obstacles to encourage individual and community initiatives for the sustainable management of biological resources. Experience shows that lifting some legal and policy barriers is a prerequisite for sustainable natural resource management. In order to ensure synergistic effects between project activities and the expected outputs of other projects to be implemented at project sites, the GEF alternative provides for mandatory Environmental Impact Assessments (EIAs) for all future projects so as to limit their adverse effects and to preserve and reinforce the results achieved as regards to sustainable production and combating desertification.

MICRO- CREDIT AND SAVINGS SCHEMES

Lessons learnt in this regards shows that activities that generate alternative incomes often need initial capitalization to take off and become financially sustainable. Revolving community systems are sustainable only when: a) potential users contribute to their capitals; b) funds are tightly managed by competent and trust worthy local people; c) checks and balances are established through communal oversight to avoid abuse and ensure timely repayment of loans; d) micro projects are vetted stringently according to business principles to ensure adequate rates of return before acceptance; and e) links to local development banks are established so as to encourage borrowers to graduate to the commercial sector.

ECO-REGIONAL PLANNING

Regional planning, which includes economic stratification; regional land use planning; population and infrastructure nodes and links; etc has been part of the baseline. Recent policies on decentralization have mandated the regional governments to conduct regional planning within the framework of a national plan. However, current regional planning approaches on biological and ecosystem factors are not based on integrated ecosystem approach principles. This will ensure that population pressure and movements (migration, transhumance) between one landscape and the next are adequately planned and managed in order to allow all development and conservation needs to be effectively integrated and addressed. In the context of this project, the two neighbouring provinces i.e. Rajasthan and Gujarat offer a golden opportunity to test and demonstrate these principles, because of their proximity with varying landscape and similar root causes. The project will build capacity for eco-regional planning at all relevant provincial, regional and local levels.

1. Intensification of agricultural production systems

These activities will target to increase forest cover/ production, crop production and livestock production. They will be aimed at encouraging the stakeholders to increase soil productivity so as to reduce the pressures on natural ecosystems and also to reduce excessive vegetation removal, overexploitation and land degradation.

i) Tree integration for building up organic matter: Forestry research has demonstrated that 30-40 trees of *Prosopis cineraria* in a field can increase pearl millet production by 40-50%. This is due to soil nitrogen enrichment with its root nodules; b) faster litter mineralization; c) tree is indigenous to the area; and d) the tree is lopped for fuel and fodder production. The fresh animal dung form use as fuel, allowing most to go into meteorological cycles for the two cropping season. The removal of the canopy opens the area to warmth and solar radiation during the cool winter season when it is needed. The bean like pods is used vegetable particularly for the poor. Integrating trees in agricultural production systems are the best option. Trees are placed in a row to allow passage for mechanized implements whether drawn by animal or by tractors. Optimal density is 100 trees ha^{-1} on average, however up to the age of 10 it can be increased to 200 trees ha^{-1}. Generally the species used in this field plantation technique are multipurpose species, which besides increasing crop yields can provide fruit forage and gum, while serving as windbreaks and stabilizing soil also. *Prosopis cineraria* in cultivated fields and *Ziziphus mauritiana* in rangelands are common in arid and semi-arid parts of Rajasthan and Gujarat. In dry regions planting of trees along field boundaries, roads and around homesteads and watering points for shade is a common traditional practice and needs replication. However, people believe that introduction of trees/ shrubs into their agricultural field reduces the crop yield and is the main barrier needs to be lifted through incentive measure.

ii) Windbreaks and live hedges: These consist implanting trees/ shrubs at the periphery of agricultural fields. This provide the advantage of reducing wind speed and water runoff speed, increasing water infiltration, mineralizing the litter or fixing nitrogen and protect crops against free grazing animals if the windbreak is sufficiently dense. Windbreaks and live hedges also provides multiple uses depending on the species and can produce fruit forage and gum, oil, forage and sustainable income. In order to avoid whirlwind effects on crops, the windbreak must be permeable to the wind. Current obstacles to the use of these techniques are the difficulties linked to the indigenous species and the knowledge on seedling production of native species is limited and needs assistance.

iii) Ecological farming: This consists of integrating crops, animal breeding and forestry (Agro-silvo-pastoralism) using conservation farming and organic farming techniques. A plot where livestock was kept pasturing in the post harvest phase during the dry season becomes enriched with manure. Seeds from the desired plant species, which were fed to the livestock, are collected and sown on the same plot, which will be cultivated over a time period while fertilizing it with manure from the animals that are kept in pens. During the next season, the animals are pastured on another plot for three consecutive years to enhance tree regeneration. The first plot may then be used for pasturing after the harvest while the second or third plots, depending on land availability (Silvo-pastoral ecosystem and forest ecosystem) is temporarily off limits to animals. Two-year forest fallows complement this rotation. Under this land management regime, the plots are fertilized used for crops, then for trees in alteration over different periods. Combined with crop rotation, this method produces the highest reported yields per space unit.

iv) **Compost pit techniques:** In agricultural areas where organic fertilization with livestock manure is a link factor, the project will undertake pilot activities demonstrating the use of compost pits using agricultural by-products and biological household waste. These products are buried and placed in a cement compost pit, which is covered while allowing some ventilation. Watering activates the mineralization process if applied. Compost pits are located either in the fields or next to the dwellings. After complete mineralization, compost is retrieved from the pits and spread on the fields. This is a very common technique, in these are where there is the highest rural density on the poorest soils, and the populations with good results are adopting it. The main constraint is the information / extension services to be provided and the cost of construction of the pit which can be used for over five years.

v) **Sheep and cattle fattening**: This is a type of pastoral intensification, which consists in taking forage to the animal instead of the traditional pasture grazing/ forest grazing. As it causes less energy loss for the animals, the methods increase weight gain considerably over a short period of time, particular when couple with close phyto-sanitary control. This is a very profitable technique adopted by several livestock farmers and even crop farmers in other countries. The most popular is sheep fattening for the annual feast, but cattle fattening is also practiced. The animals may be bought during the "junction" period when prices reach their lowest level and are then fattened for resale, realizing upwards of 100% profit per head. The main constraints are providing information and making the initial investment.

2. Reforestation and conservation:

i) **Forest regeneration:** Experiences show that local species are better suited to regenerate the ecosystems of which they are natural components providing habitat and food for the fauna. These often multiple use local species are competitive over the long term and are drought resistant while the exotics can be harvested much sooner, and 2 or 3 times for the same tree owing to stump regeneration. Local species generate greater economic and financial gains due to their multiple uses; however, this waiting period alone is enough to discourage investment in regeneration of indigenous species. In this context, in order to remove the obstacles to reforestation with local species there is a need for supportive research activities on the silviculture of local species, the creation of private and community tree nurseries for endemics, sustainable management technologies for these species as well as dissemination and diffusion of lessons learned in this area.

ii) **Assisted regeneration:** There is increased interest in the protection and stimulation of natural regeneration where mother trees/ shrubs are available and the area is in condition to be recovered. Most of the species in dry areas have a strong regeneration capacity. This regeneration capacity is viewed as a form of adapting to a highly variable environment like dry areas of Rajasthan and Gujarat. *Prosopis cineraria, Ziziphus* sp. and *T. undulata* have been explained by their ability to produce through stump/ root sucker sprouts. Soil working/ site preparation practices has been found to be useful to increase the soil water availability and sprouting vigour of the species. Digging a ring around the tree, V- ditches and the trenches not only facilitated the natural regeneration but also control the water erosion problem and soil losses.

3. Soil and water conservation

i) Water harvesting measures: In the sandier tracts, the villagers of the Thar Desert had evolved an indegenious system of rain water harvesting known as *Kunds*, the local name given to a covered under ground tank was developed primarily for tackling problem of drinking water. These are either owned by communities or privately. Village ponds *(nadis), Kundis and layikas* in Rajasthan and *virdis* in Gujrat were common for meeting the drinking water needs of the inhabitants. Earthen dam/ checkdam are the important technical know how in hilly/ ravenous areas to improve water regime, recharge ground water and enhance the productivity not only through forest regeneration but also through increased agricultural productivity.

ii) **Rock bunding:** Small dikes (rock bunds) are constructed, placing a line of stones on hills in a perpendicular orientation to the slope, in order to reduce the speed of surface runoff during the rainy season. The technique can be applied to one or several fields in the same catchment area, at village level for instance. This is where the technique is most effective and efficient as it reinforces individual actions undertaken in each field. This technique enhances water infiltration and organic matter and silt retention. It is proven technique to rehabilitate degraded soil and increase land potential in the village territories. The major constraint is that it requires hard work to collect the stones and great care to construct the dikes. Such initiatives can be supported and encouraged. In addition, it should be noted that maintenance work is far less demanding and that once they are constructed; the farmers see their profits, which ensures sustainability. The constraint lies at the initial stage in convincing the stakeholders of the benefits of the technique. The project will do so with awareness raising techniques, including organizing cultural events, shows, competitions, etc. Farmers will also be encouraged to take micro-loans to hire labourers for the work.

4. Sustainable management of pastureland and CARs

i) Pastureland management: Among the different land use units in the rain fed agroforestry-eco-system, the permanent pastures are the most degraded and neglected. In many instances these are devoid of even the basal vegetation cover. Since the land does not belong to any individual, there is no concern for it. Overgrazing and other forms of destruction of natural vegetation, as well as encroachment, have increased so much that other poor communities have largely replaced the original plant communities. In the dry areas, pelletted seeds of grasses such as *Lasiurus sindicus, Cenchrus ciliaris* and *Cenchrus setigerus* may be planted. Such simple interventions can increase the carrying capacity of an average permanent pasture from 2.5 sheep ha^{-1} to as much as 4.5-6.9 ha^{-1} sheep in sandy soils and 9.0-13.8 ha^{-1} sheep in loamy sand soils. Multipurpose trees and shrubs such *as Prosopis cineraria, Ziziphus nummularia, Capparis decidua, and Acacia nilotica* are suitable for silvipastoralism. The areas marked for development need to be protected from grazing for at least two years. The controlled rotational grazing can then be introduced. Community mobilization is thus the central issue and replacing the large herds of poor quality animals with improved quality livestock of smaller number will be encouraged which can improve grazing land. In order to reverse the process, a serious and sustained effort (perhaps even legislation) is warranted in this direction.

ii) Pasture improvement: In many African countries a number of pasture units are placed off-limits to grazing and enriched both with palatable with legume species and with shrub or tree forage species such as *Acacia senegal*, *Prosopis cineraria*, *Z. nummularia* etc in a pre-determined period of time. The enriched section are open to grazing other blocks previous used are enriched and placed off limits. In this connection over the duration of the project, it will be possible to assess the results of such rotation with regards both sustainable development and conservation. This rotation system provides quality forage at all times while protecting the natural habitat of wild faunaal species, which incidentally also benefit from this quality forage. In addition to this benefit for the wild fauna, pastureland management is also favorable to environmental balance and provides income from the sale of gum arabic and other by products to generate the income for the rural. The obstacle to the realization of these pasture land improvements is the fact that pastoralism is not explicitly included in legal provisions as a land development criterion and therefore is not considered as such by land use planners, who allocate land according to such criteria. Therefore, no land has ever been allocated either individually or collectively for pastoral. Pastureland access is open and free of charge to anyone and as a consequently no pasturelands are not only increasingly degraded, leading to transhumance over longer distances with the attendant conflicts, but they are also subjected to clearing for cultivation thus relegating the livestock on mediocre soils. This technique also includes grazing and water fees on improved pastures, which should generate revenues, which are put back into communal management of the system.

5. Control of sand movement and wind erosion

Sandy soils and poor vegetation are the basic characteristic features of arid regions. Movement of sand through wind action is a major hazard in these areas. Strategies to control land degradation therefore should focus on control of wind erosion as a basic step.

i) Stabilization of sand dunes: The old dunes have greater stability and mostly cultivated whereas the new dunes are highly mobile and devoid of vegetation. Much of the sand dune stabilization programme is directed towards the old dunes, so that the production potential of these lands can be restored. The activities include (a) protection of the area from human and livestock encroachment; (b) creation of micro-windbreaks either with dead material or the live micro wind breaks on the dune slopes, using locally available shrubs either in a checker board pattern or in parallel trips; (c) direct seeding or transplantation of indigenous/ exotic species; (d) plantation of grass slips or direct sowing of grass seed on leeward side of micro-windbreaks; and (e) management of revegetated sites. Bio-fencing, using locally non-palatable species, is a cheaper and more effective form of barrier. Definitive fixation, achieved through the establishment of a permanent plant cover. For this we need to establish perennial tree or shrub cover. There is no longer the risk of these being destroyed by moving sands that might otherwise have exposed plant roots or damaged their aerial parts through abrasion. Usable woody species suitable for the region are *Calligonum polygonoides*, *Lycium barbarum*, *A. tortilis*, and others such as *Callotropis sp.*, *Balanites aegiptiaca*, *Prosopis sps.*, *Casuarina equisetifolia*, *Ziziphus* sp, *Acacia* sp., etc. Introduction of under shrubs like *Cassia angustifolia* (medicinally important species) and locally available grass species (for fodder production) helps in early stabilization of dune and provides additional income from these.

ii) Shelterbelt/wind break plantation: Experience suggest that across-the wind plantation of a 13 m wide tree belt, interspersed with 60 m wide grass belt, provides the best results. Establishment of micro-shelterbelts in noble lads, by planting tall and fast growing plant species such as castor bean on the windward side, and shorter crops such as vegetables in the leeward side of tall plants helped to increase the yield of lady's finger by 41%, and of cowpea by 21 percent, over the control. In spite of the good results the community shelterbelts in arable lands are not very popular with the farmers, especially as the technique normally cut across their field/holding boundaries. Therefore, of late, it has been suggested to plant trees on field bunds across the direction of wind.

6. Saltland management

i) Ameliorative measures: Planting of nursery grown seedlings is preferred in saltland plantation. Preliminary results indicated that inoculation of *A. ampliceps* with salt tolerant *Rhizobium* increases seedling growth in the field. Mechanical ripping of soil with tynes to break up plough hardpans, clay layer or calcium carbonate hardpans, or manual digging or mechanical auguring of planting holes and the soil replaced in the hole may be chemically amended with gypsum and fertilizers with caution to avoid smooth walls of hole. Use of saucer pits and furrows as water harvesting techniques is appropriate in drought-prone and /or saline soils without a high water table. Use of mounds in areas affected by waterlogging to give seedlings access to a volume of aerated soil above the water table. The trench ridge technique is widely used in Pakistan and India and the double ridge mound have been very effective in aiding shrub and tree growth. In the double ride mound method the trough between the ridges where seedlings are planted, collects rain, which leaches salt from the soil below the trough i.e. the seedling root zone. These mounds can be manually or mechanically constructed.

ii) Provision of subsurface drainage: This can be provided either by vertical drainage (e.g. pumping from tube well) or horizontal drainage (e.g. deep open ditches or trenches), slotted pipe drains and mole drains or both to remove excess water.

iii) Application of mulches: Mulches reduce evaporation (drying of surface soil) and accumulation of salt at and near the soil surface. Mulches include straw, cotton, vermiculite, sand and polythene. Mulch application had the major beneficial effect on survival probably through reducing surface soil salinity, but gypsum and fertilizer application had a greater effect on growth, probably related to better root growth due to improved soil structure and nutrient supply. The effects of these treatments have tended to decline after several years.

iv) Addition of organic and inorganic fertilizers: Sodic soils are often deficient in organic matter, nitrogen, zinc and other nutrients. Gypsum can be mixed in with sodic soil to replace excess Na with Ca, but this will only be successful if sufficient water is provided to leach excess Na beyond the root zone. Significant survival and growth advantages accrue from use of farmyard manure in addition to gypsum with sodic soils either mixed with original soil in auger holes or broadcast into the soil. It leads to more efficient use of fertilizers by reducing soil pH.

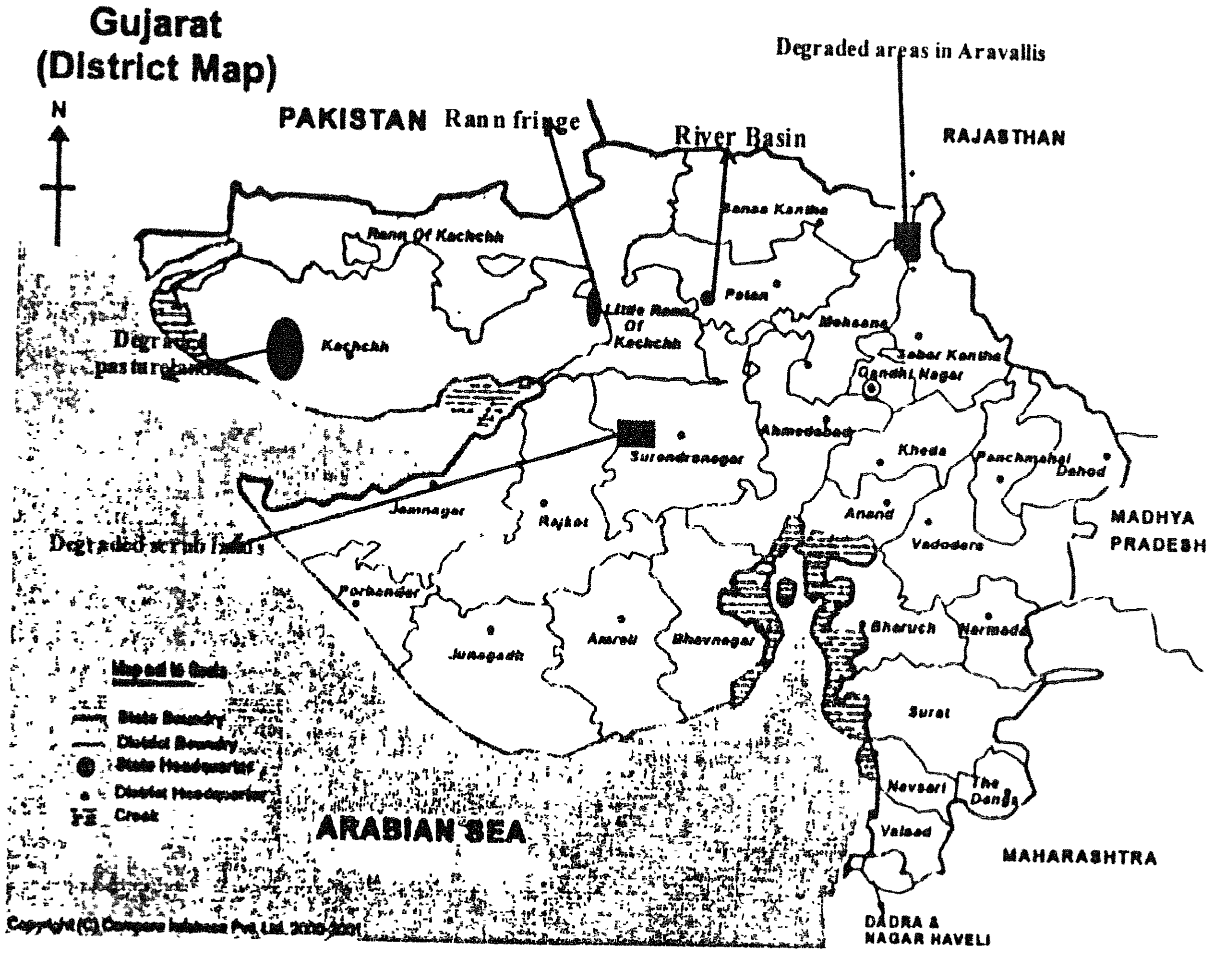
7. Income diversification

i) Beekeeping: Honey production will simultaneously generate sustainable income and protect the forest areas where this activity is conducted. Honey production while improving the local diet will also generate sustainable income through sales. The only obstacles to bee keeping are the lack of access to initial micro credit for the population so the isolated villages located at the forest periphery. The durability of this activity resides in its economic and financial profitability. For bee keeping, the initial funds required are for the purchase of a protective suit and chemicals to put the bees to sleep for 35 minutes. The honey production season goes from Jan – August including agricultural as well as forestry areas.

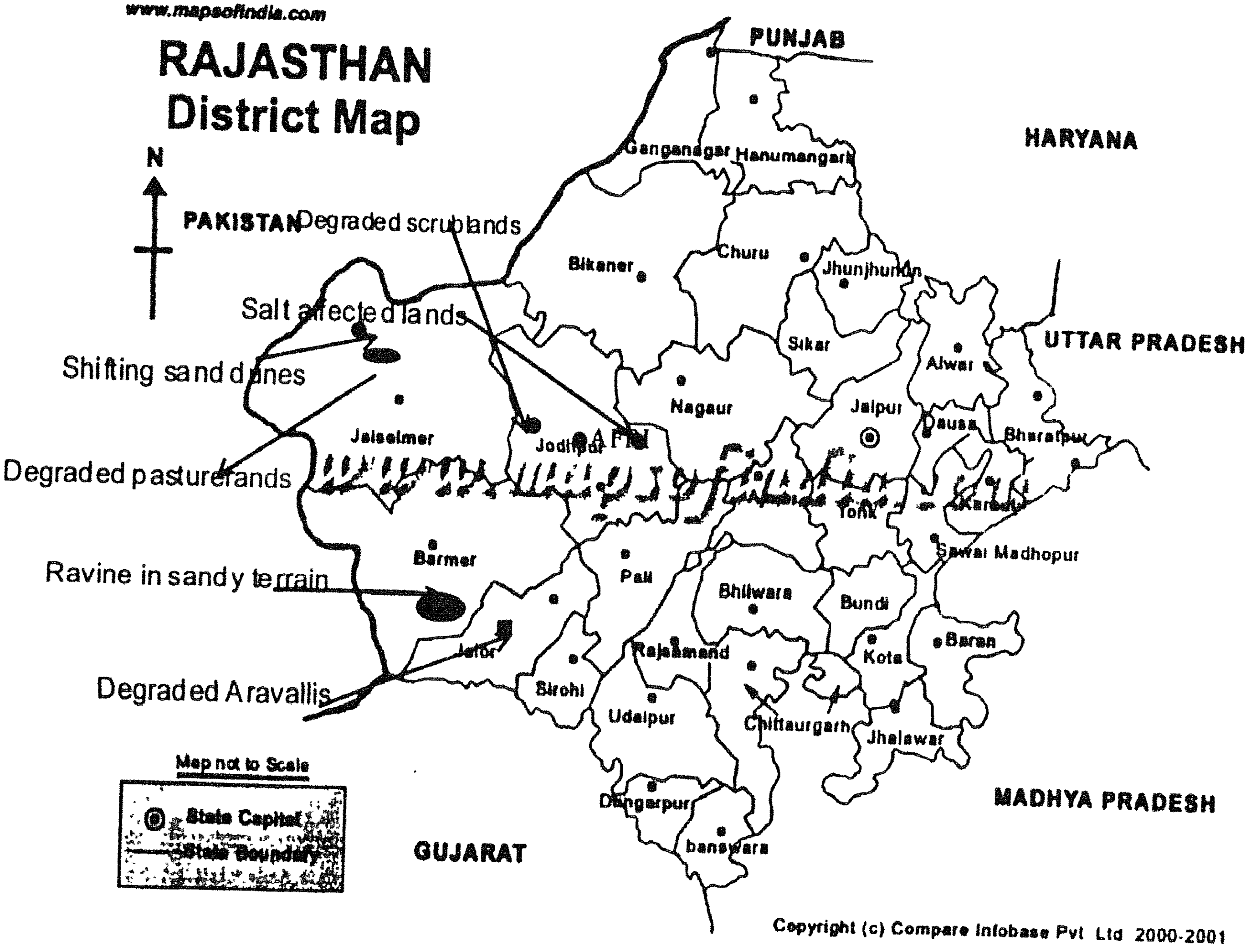
ii) Poultry farming: Poultry farming is another source of income generation for the peoples of the dry areas. It will not only generate sustainable income, improve local diet but also helps in reducing the population of small ruminants. Durability of this activity depends upon its economic and financial profitability. The main obstacle to this technique is the micro-credit for the population of the isolated villages located in the remote areas. The GEF funding will provide easy access to start this activity to diversify the income of the locally villagers.

iii) Hay harvesting: As a consequence of village land degradation, straw to build or repair huts in the villages has become a scarce therefore expensive, commodity and its harvesting in the forest areas the only place where it is still available, is a lucrative activity. As a result despite explicitly prohibition on straw harvesting in the forest areas and the dangers of confronting with forestry officials, the population indulge in this activity either for their own period use or to sell the straw which is in high demand as the hut roofs have to redone every other year to remain water tight. The GEF alternative, while eliminating the obstacles to a conservative management of biological resources will test the option of involving the local populations in the cleaning of peripheral firebreaks and of amending legal status so that they may use the straw collected in this manner to use or sell as they please. Such an activity will protect the ecosystems against forest fire and generate substantial sustainable income.

Annex I: Map of Project Sites in Gujarat



Map of Project Sites in Rajasthan



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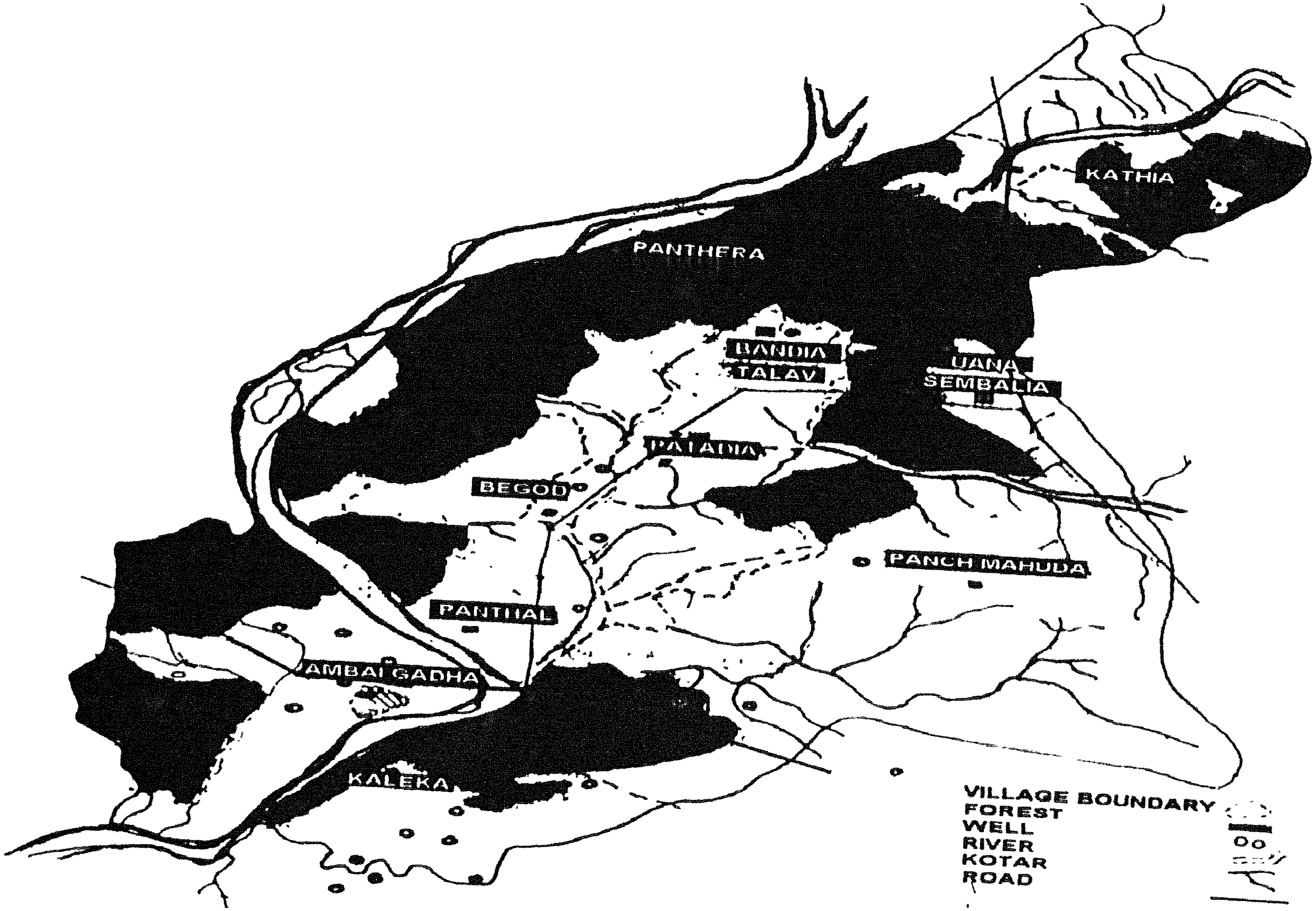
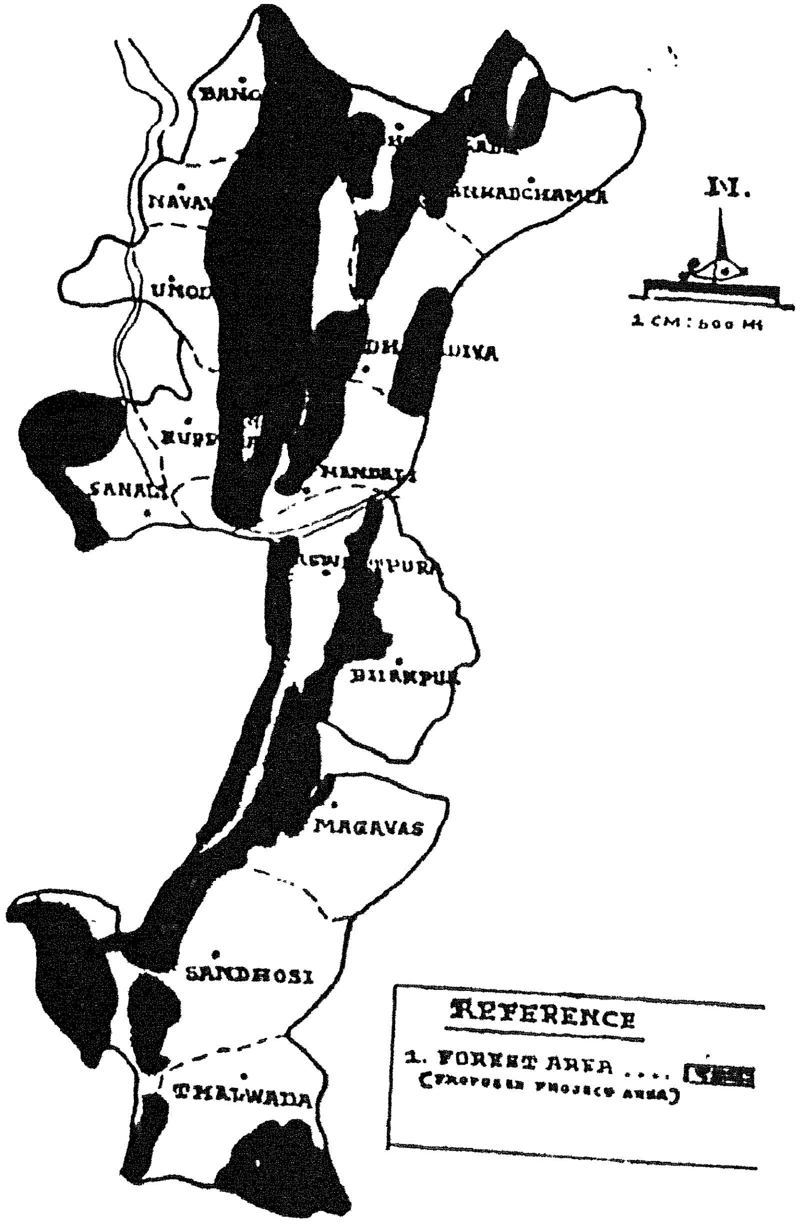
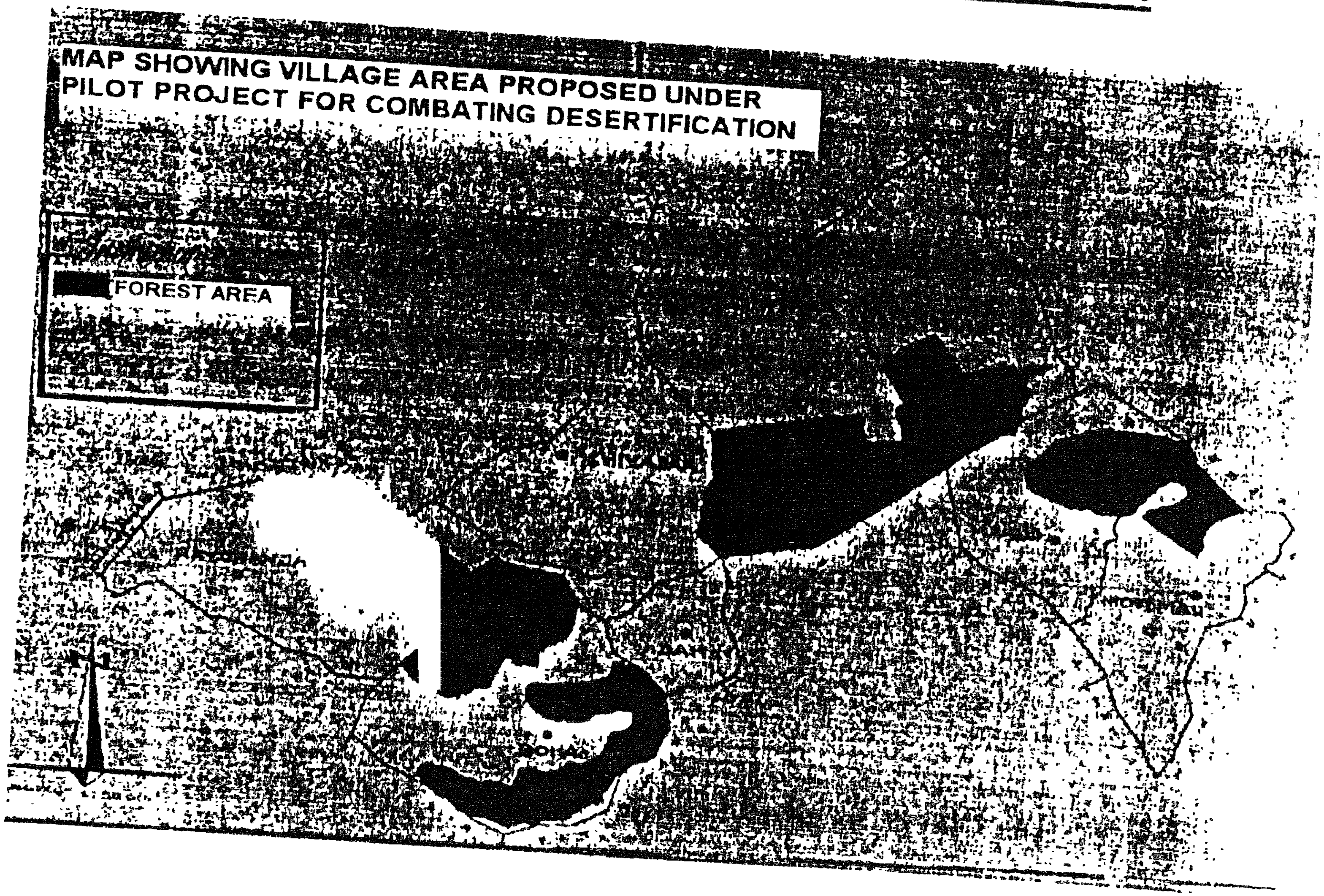
Map of Khedbrahma site of Sabarkantha District



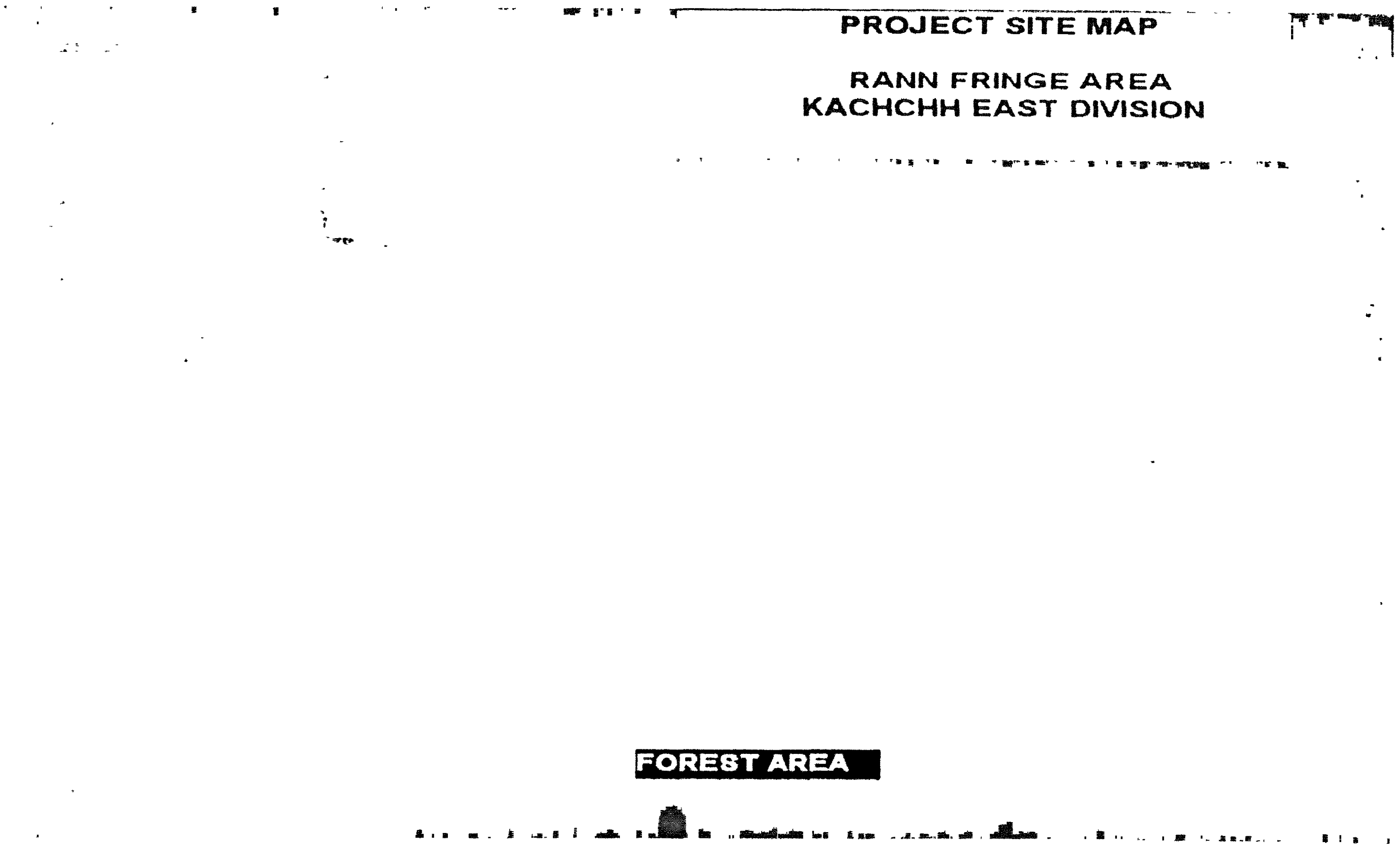
Map of Danta site of Banaskanta District



Map of Nakhat Rana site of Kutch District


MAP SHOWING VILLAGE AREA PROPOSED UNDER PILOT PROJECT FOR COMBATING DESERTIFICATION
FOREST AREA

Map of Adhesar site of Kutch District



Map of Chotila site of Surendra Nagar